QUARTERLY REPORT NO. 8

(JUNE 1,1976 TO AUGUST 31,1976)

ENVIRONMENTAL BASELINE DATA COLLECTION

AND

MONITORING PROGRAM

FEDERAL PROTOTYPE OIL SHALE

LEASING PROGRAM

TRACTS U-a and U-b

UTAH

WHITE RIVER SHALE PROJECT

vtn

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I. INTRODUCTION

This document is a summary of work conducted from June 1 to August 31, 1976, as part of the environmental baseline monitoring program for Tracts U-a and U-b. The baseline program is being conducted in accordance with the Partial Exploration Plan, Environmental Baseline Data Collection and Monitoring Element, submitted July 1, 1974, and the Conditions of Approval developed by the Area Oil Shale Supervisor (AOSS) for various sub-elements of the program. As requested by the AOSS, the field data collected for this quarter have also been submitted and are on file in the AOSS office in Grand Junction, Colorado.

This report is the final quarterly baseline report and interprets and analyzes data that will be incorporated within the Final Environmental Baseline Report (FEBR), which covers the period from the beginning of each baseline monitoring program element to January 15, 1977, or a period of not less than two years.

II. WATER RESOURCES

A. WORK COMPLETED

1. SURFACE WATER HYDROLOGY

Modifications to the program were instituted as specified in the revised Conditions of Approval, in which Station S-4 (White River above Southam Canyon) was deleted from the data-collection program. Otherwise, monitoring continued as in past quarters.

2. SURFACE WATER QUALITY

Monitoring continued as in past quarters with the addition of the following modifications:

1. Antimony, cobalt, silver, and tin are to be added to the quarterly analysis schedule.

2. DOC fractionation analysis is to be performed on samples collected at stations S-1, S-11, S-2, and S-6 during low flow.

3. Termination of data collection of S-4.

3. GROUND WATER LEVEL MONITORING

Static water levels were measured in all monitoring wells in June, July, and August. Continuous water level monitoring was conducted at the P-1, P-2 upper, P-2 lower, and P-3 sites.

4. GROUND WATER QUALITY

Samples were collected from the alluvial wells in June (semi annual), July, and August. Semi-annual pumped samples were collected from the bedrock aquifer wells in June. All samples were submitted for analysis.

B. DATA SUMMARY

1. SURFACE WATER

a. Streamflow

White River

The preliminary measurements of streamflow in the White River near Watson Utah in 1976 (Station S-3) are shown on Figure II-1. Although data from the other three stations on the White River are not yet in a form suitable for direct comparisons, the data now available indicate that flow at these stations is very similar to the flow at Station S-3. The final results for all of the stations available for the Final Environmental Baseline Report.

Streamflow during 1976 was similar to that of 1975 during baseflow and lower basin snowmelt, but upper basin snowmelt this year was earlier and produced a lesser volume of runoff than that of last year. Because of less snowmelt, it is possible that the average flow this year may be as much as 4.25 m^3/s (150 cfs) less than the average of 20 m^3/s (700 cfs).

Evacuation Creek

Figure II-2 shows the preliminary streamflow measurements near the mouth of Evacuation Creek during the 1976 water year. Flows recorded through May have been similar to last years flows, but peak flows from snowmelt occurred approximately 20 days earlier. The data are being reduced, so detailed analysis will not be possible at this time.

Hells Hole Canyon, Southam Canyon, and Asphalt Wash

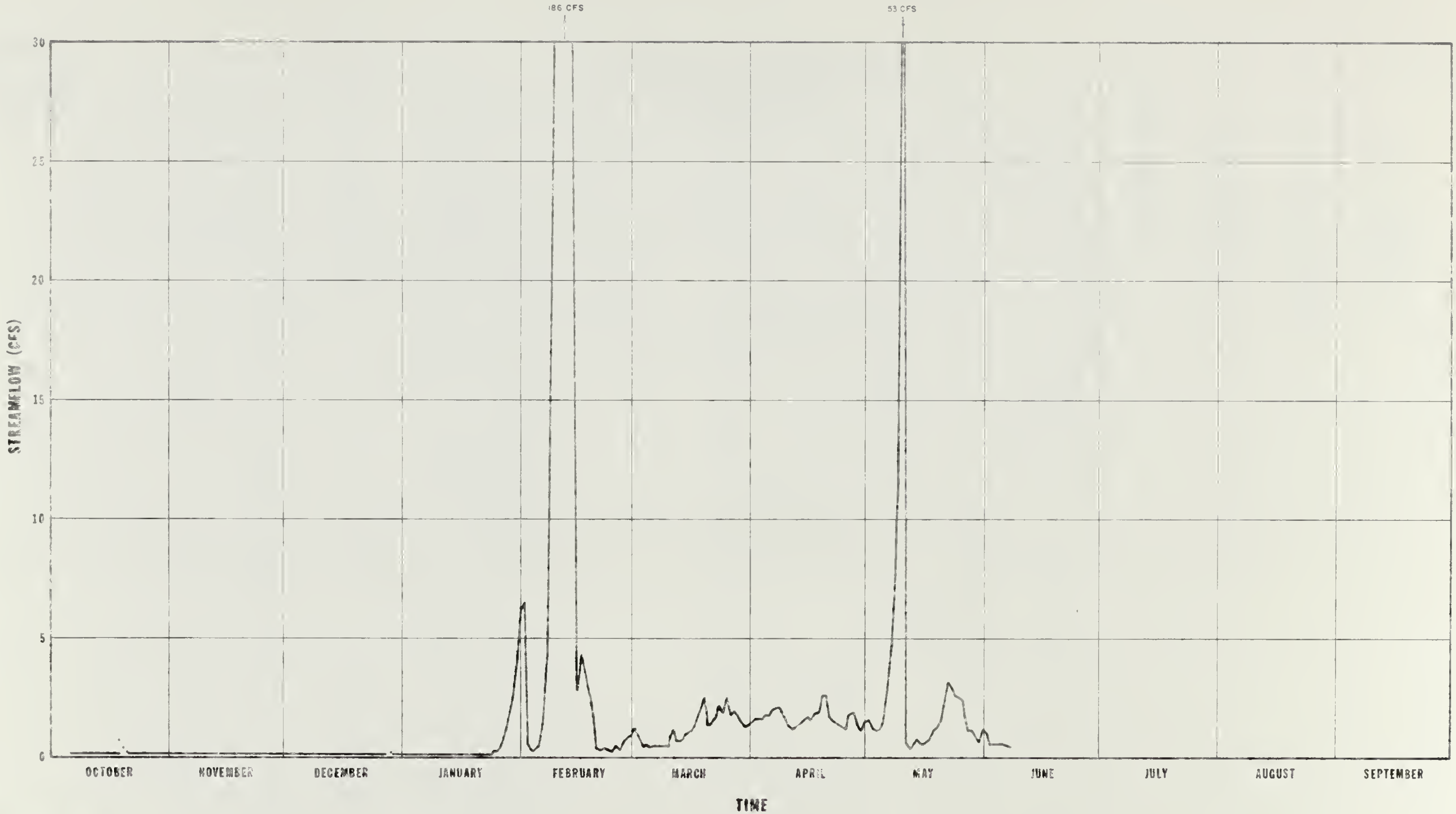
All three canyons had flowing water between February 10 and February 15 and for short periods at other times between March and June. From October through June the stations at the mouths of Hells Hole Canyon, Southam Canyon, and Asphalt Wash have recorded approximately 3.68 ha/m (2.8 ac-ft), 12.6 ha/m (9.5 ac-ft), and 36.4 ha/m (27.4 ac-ft) total flow, respectively. One of the more significant flows occurred in Southam Canyon on June 22 as the result of a rainstorm

STREAMFLOW

WHITE RIVER NEAR WATSON, UTAH - (S-3)

OCTOBER 1975 - SEPTEMBER 1976

FIGURE II-1



STREAMFLOW
EVACUATION CREEK NEAR MOUTH BELOW WATSON, UTAH - (S-2)
OCTOBER 1975 - SEPTEMBER 1976

FIGURE II-2

that dropped 1.5 cm (0.6 in.) in 25 minutes and totaled about 2.0 cm (0.8 in.) over the basin from the duration of the storm. The runoff from this storm had a volume of about 10.8 ha/m (8.1 ac-ft) or averaged about 0.08 cm (0.03 in.) over the Southam Canyon drainage area.

b. Precipitation and Evaporation

The precipitation and evaporation records from October 1975 through July 1976 are shown on Table II-1. The precipitation values are about the same as during the same period the preceding year, although its spatial and temporal distribution is different. Evaporation during May was only 61% of the evaporation recorded last year during that month. This decrease is probably the result of more cloudy and cool days during May of this year.

2. WATER QUALITY

a. Streams

White River

Water Quality in the White River this year showed the same trends and concentrations as in the first year. This can be seen by comparing figures II-3 through II-8 with the equivalent figures and discussion in the First Year Environmental Baseline Report (FYEBR) (Figures ~~II-20 through II-31~~). 31).

Evacuation Creek

The trends and concentrations in the quality of Evacuation Creek this year was also similar to those of last year, as confirmed in a comparison of figures II-9 through II-14 with the equivalent figures and discussion in the FYEBR.

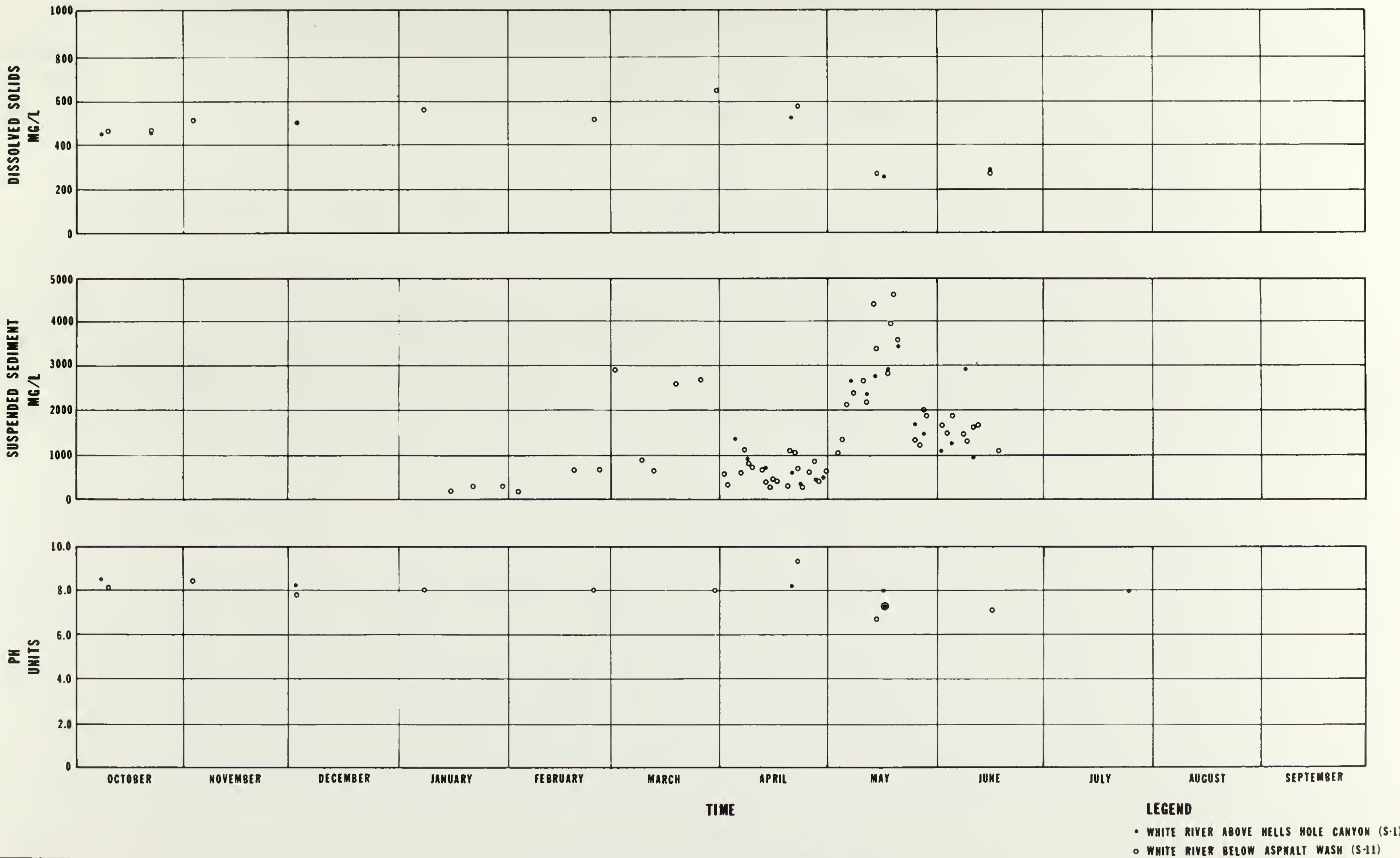
Southam Canyon, and Asphalt Wash

So far this year three samples have been collected from Southam Canyon and Asphalt Wash. All six of these samples were from snowmelt runoff and are therefore fairly low in dissolved solids. (All were less than 310 mg/l and

TABLE II-1

1976 PRECIPITATION (CM)

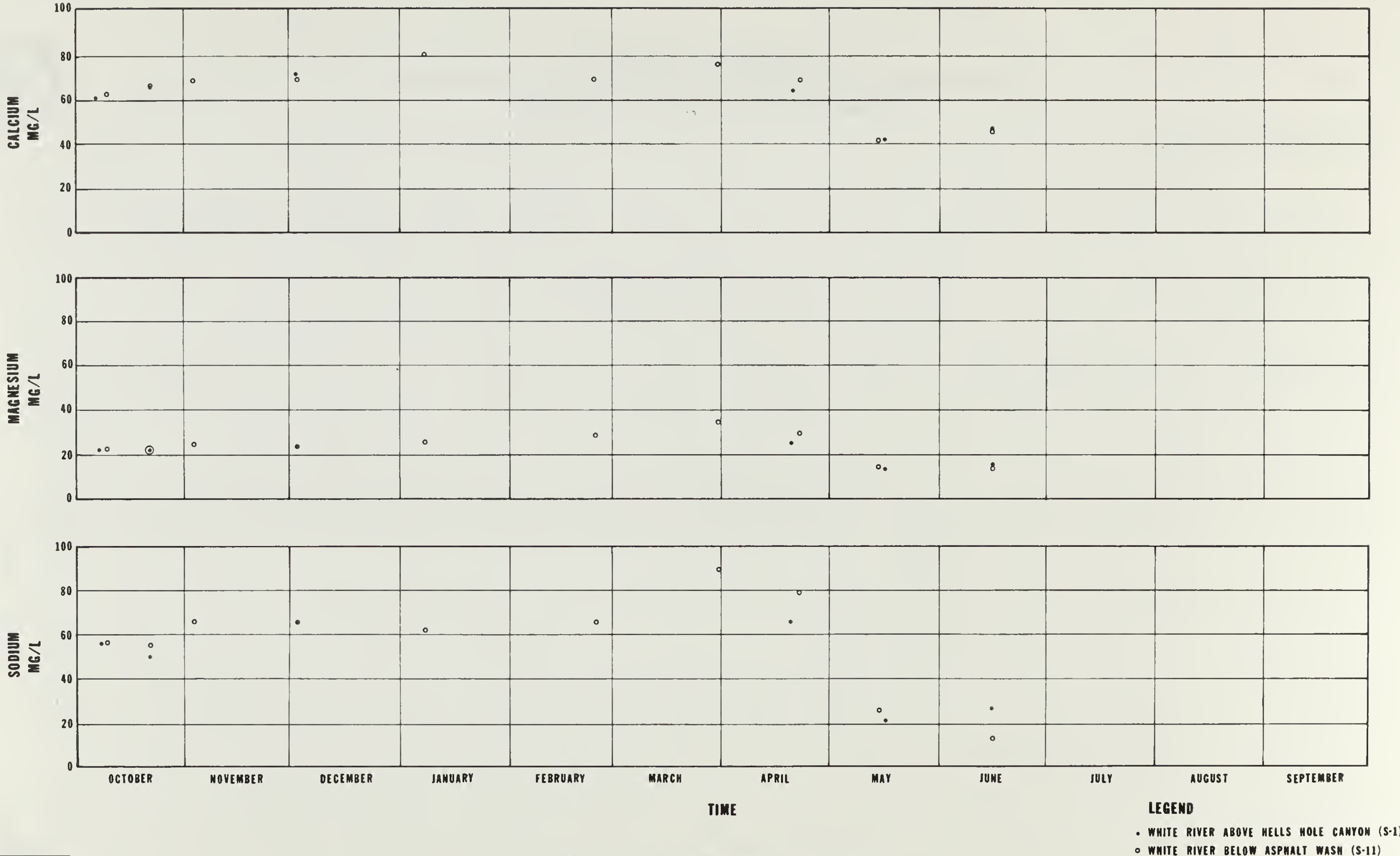
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct-Apr	May-Sep	Ann.
Evaporation I								8.59							
Evaporation II								8.05							
RS-PS	4.01	.84	.99	.74	.74	3.20	2.39	4.37	2.18	2.44			12.90		
RS-13	3.73	.94	3.91	.56	.99	3.00	1.91	3.66	3.05	1.19			15.04		
RS-12	3.53	.89	4.47	.71	.46	3.18	1.85	2.95	1.42	1.17			15.09		
ARS-12					.5	3.3	1.8	3.3	2.3						
RS-11					.99	3.15	1.60	2.92	1.42	1.27					
RS-9	5.33	1.04	4.37	.84	1.14	3.23	2.64	3.43	2.06	1.02			18.59		
ARS-9					.8	3.1	2.5	3.3	2.5						
RA-8					.91	2.29	2.59	3.20	1.85	1.55					
ARA-8					1.0	2.0	2.3	2.8	2.3						
RS-6	3.53	.84	1.83	.66	2.08	2.62	3.23	2.84	1.63	1.09			14.79		
RS-4					.84	3.20	2.01	4.22	2.74	.46					
ARS-4					.8	2.5	2.0	4.6	2.8						
RS-3	3.38	.89	1.42	.51											
RA-2					.89	2.72	1.68	2.97	2.44	.91					
ARA-2	4.1	.8			1.0	3.1	1.3	3.8	3.3						
RS-1	3.48	.81	1.68	.46	.43	1.04	2.77	3.02	1.98	1.55			10.67		
RP-1					.91	2.18	2.34	1.83	1.52	.91					
ARP-1	3.8	1.0	.8	.5	1.0	2.5	2.3	2.8	2.5				11.9		



VARIATION OF GENERAL CHARACTERISTICS

WHITE RIVER ABOVE HELLS HOLE CANYON (S-1) AND WHITE RIVER BELOW ASPHALT WASH (S-11)
OCTOBER 1975 - SEPTEMBER 1976

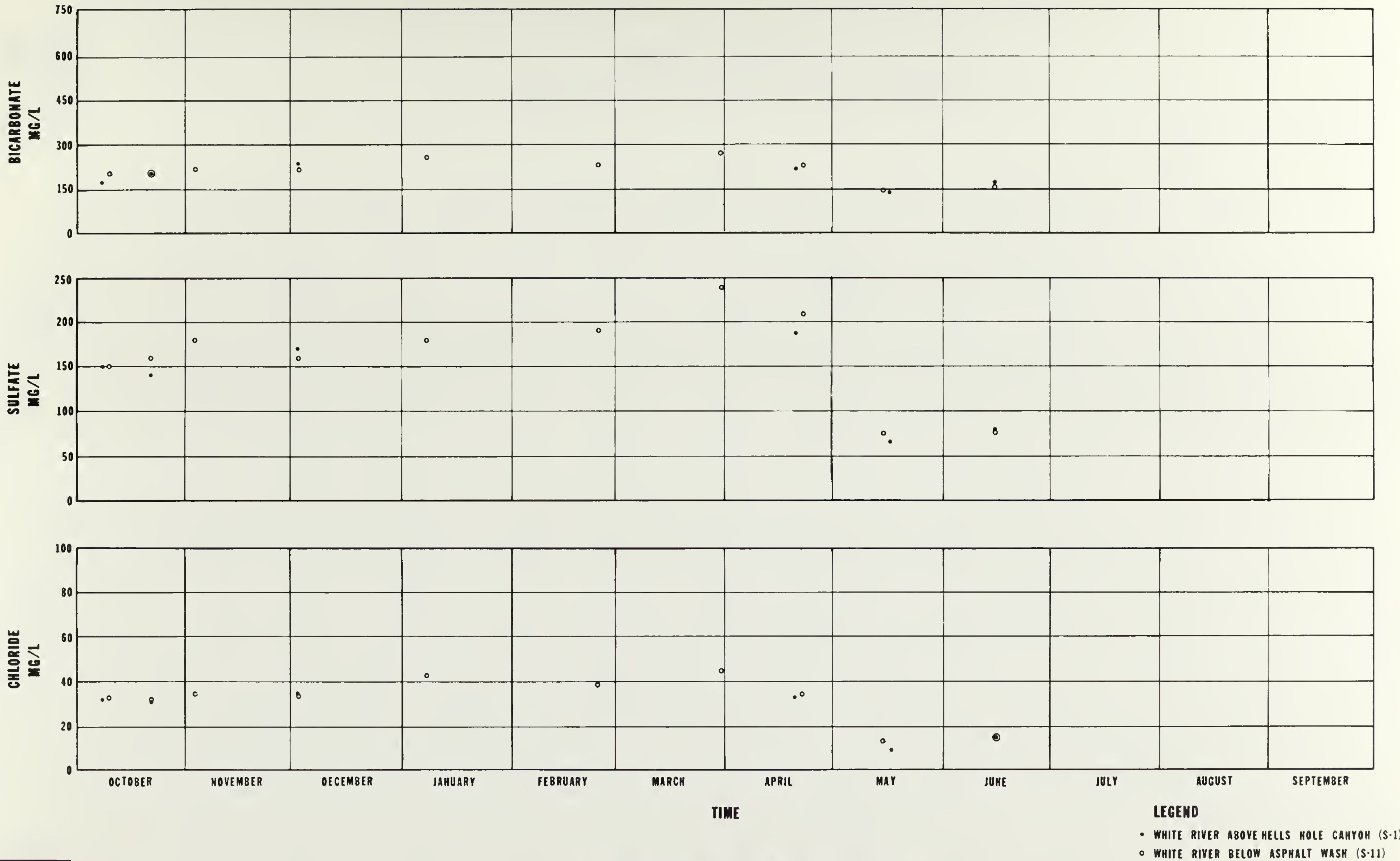
FIGURE II-3



VARIATION IN TIME OF MAJOR CATIONS

WHITE RIVER ABOVE HELLS HOLE CANYON (S-1) AND WHITE RIVER BELOW ASPHALT WASH (S-11)
OCTOBER 1975 - SEPTEMBER 1976

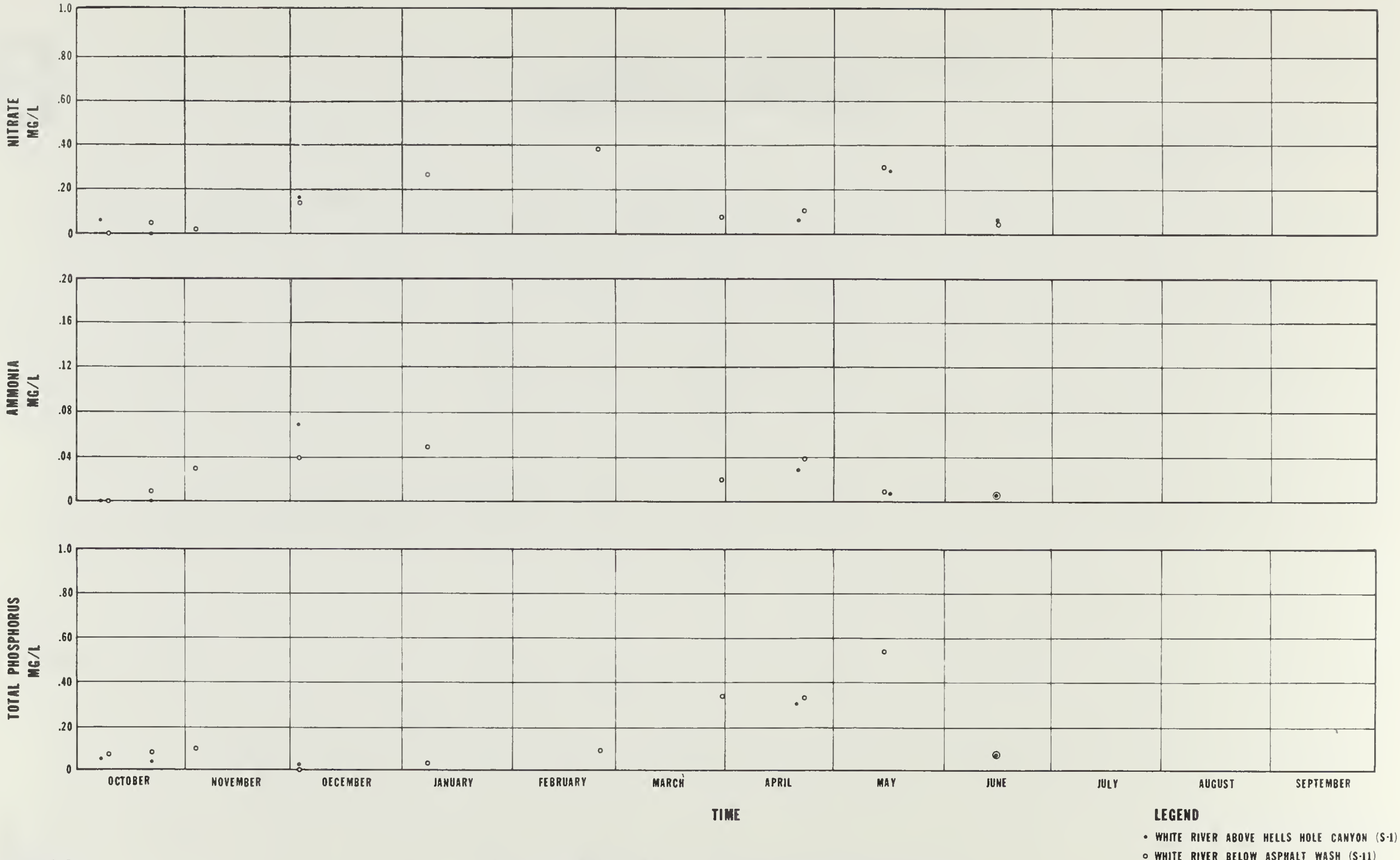
FIGURE II-4



VARIATION IN TIME OF MAJOR ANIONS

WHITE RIVER ABOVE HELLS HOLE CANYON (S-1) AND WHITE RIVER BELOW ASPHALT WASH (S-11)
OCTOBER 1975 - SEPTEMBER 1976

FIGURE II-5

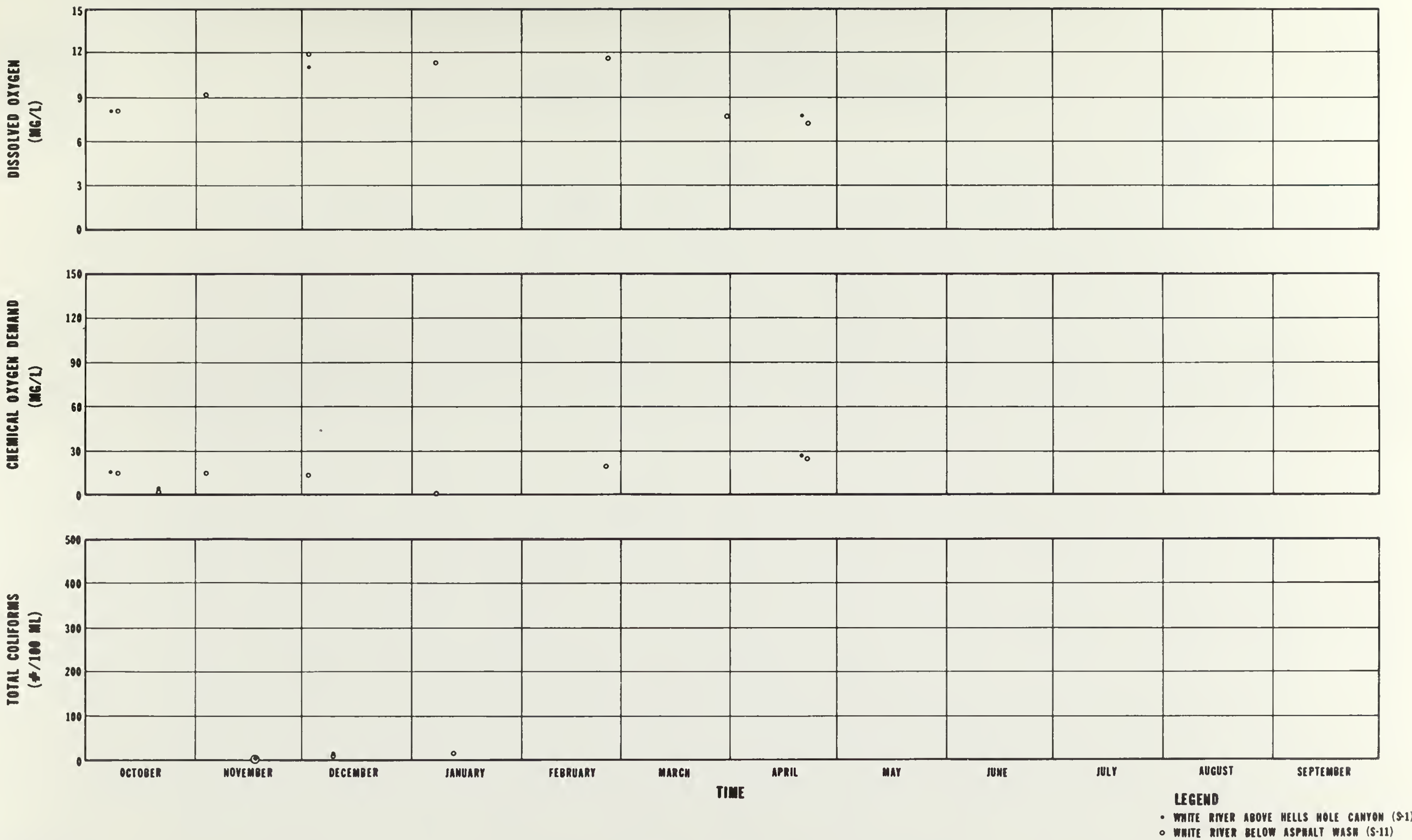


VARIATION IN TIME OF REPRESENTATIVE NUTRIENTS

WHITE RIVER ABOVE HELLS HOLE CANYON (S-1) AND WHITE RIVER BELOW ASPHALT WASH (S-11)

OCTOBER 1975 - SEPTEMBER 1976

FIGURE II-6

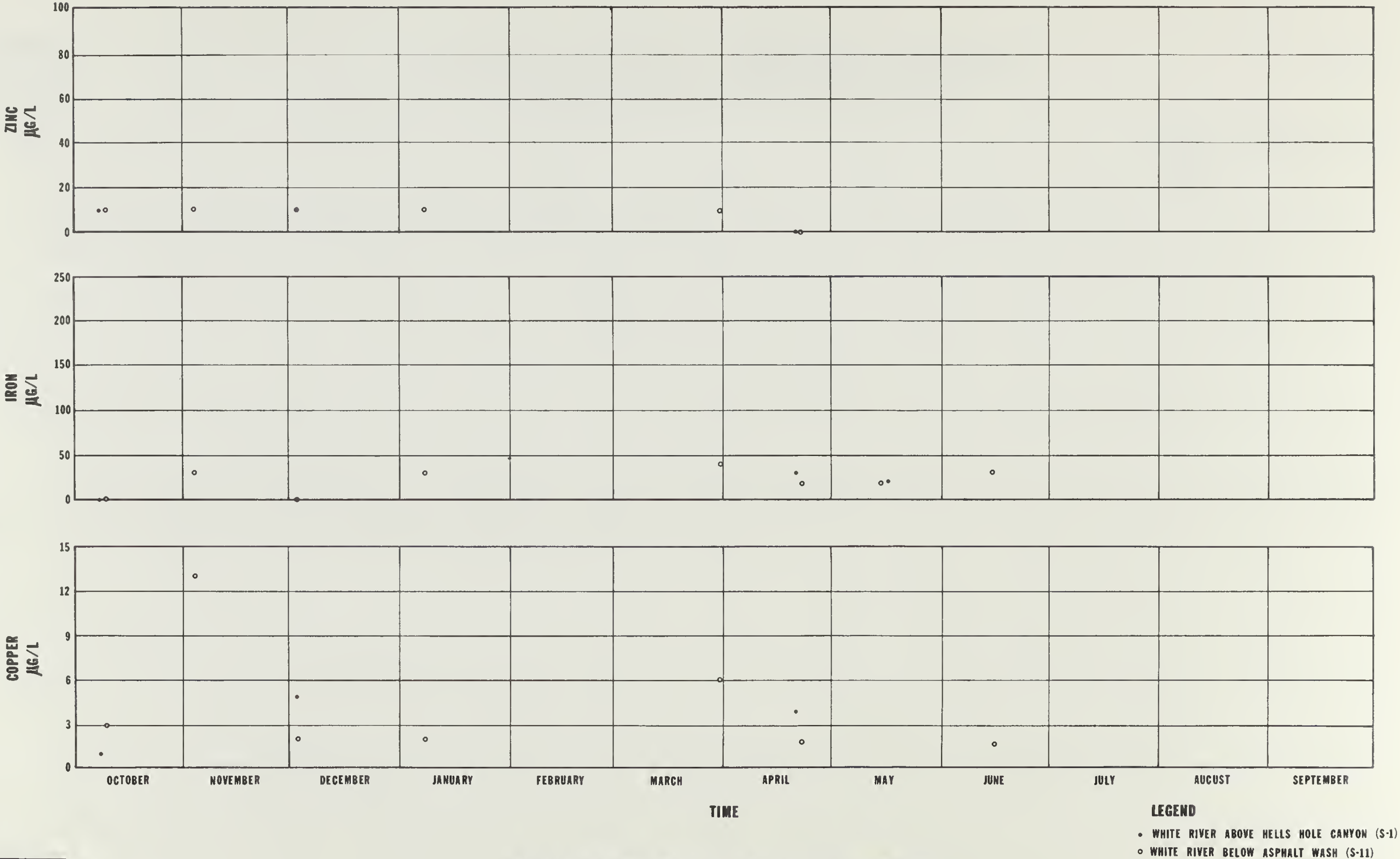


VARIATION IN TIME OF BIOCHEMICAL CONSTITUENTS

WHITE RIVER ABOVE HELLS HOLE CANYON (S-1) AND WHITE RIVER BELOW ASPHALT WASH (S-11)

OCTOBER 1975 - SEPTEMBER 1976

FIGURE II-7

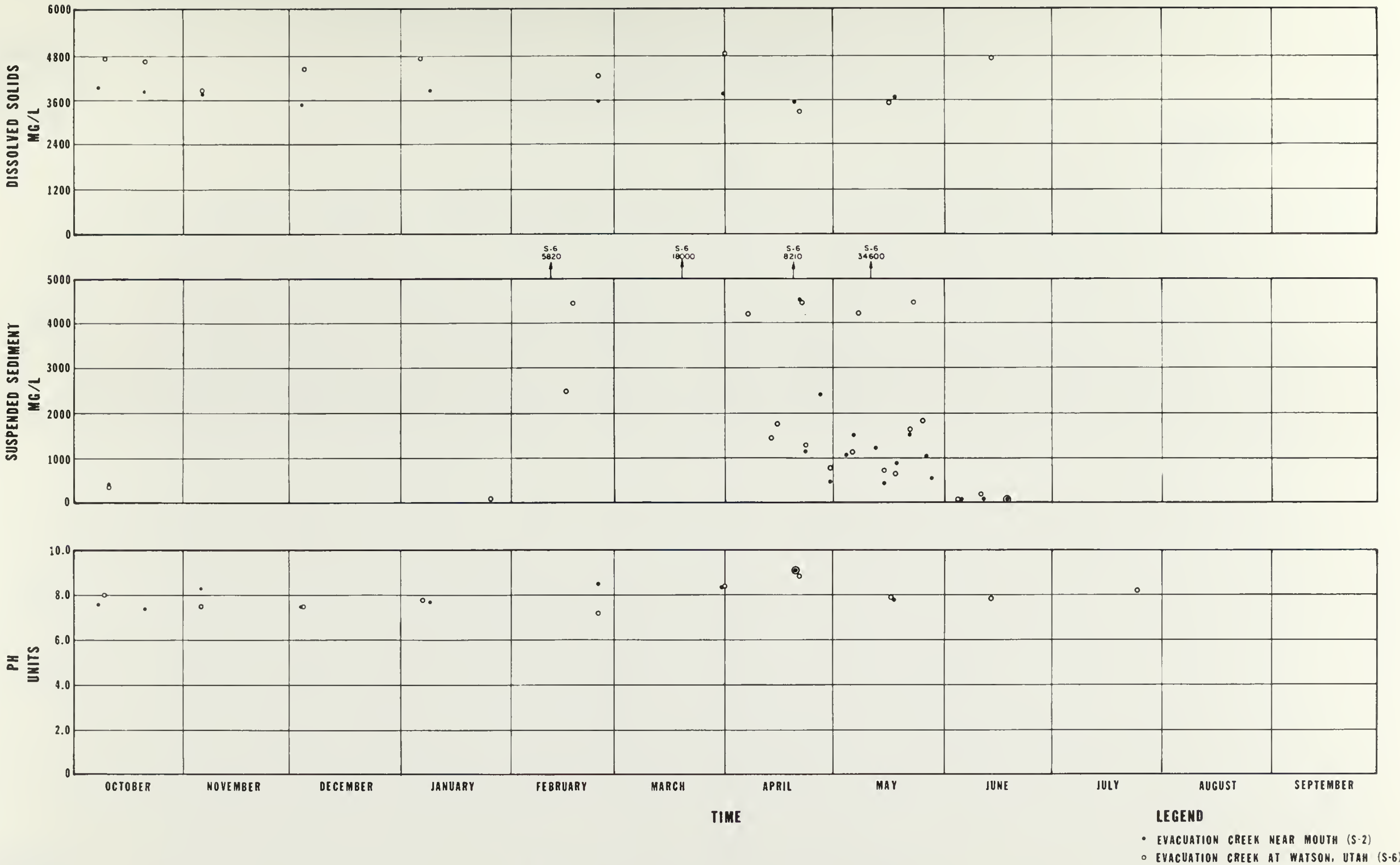


VARIATION IN TIME OF SOME TRACE ELEMENTS

WHITE RIVER ABOVE HELLS HOLE CANYON (S-1) AND WHITE RIVER BELOW ASPHALT WASH (S-11)

OCTOBER 1975 - SEPTEMBER 1976

FIGURE II-8

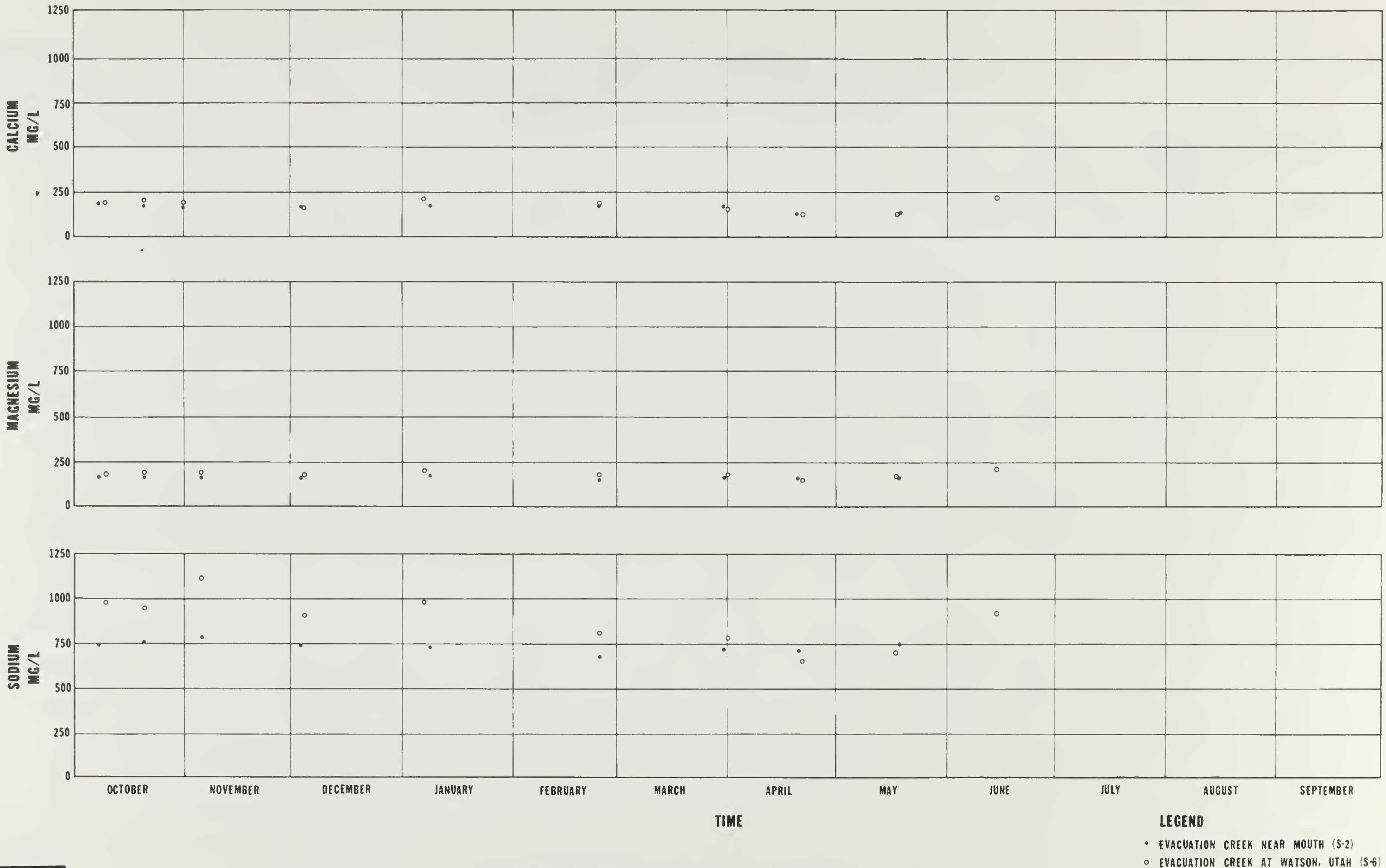


VARIATION OF GENERAL CHARACTERISTICS

EVACUATION CREEK NEAR MOUTH (S-2) AND EVACUATION CREEK AT WATSON, UTAH (S-6)

OCTOBER 1975 - SEPTEMBER 1976

FIGURE II-9

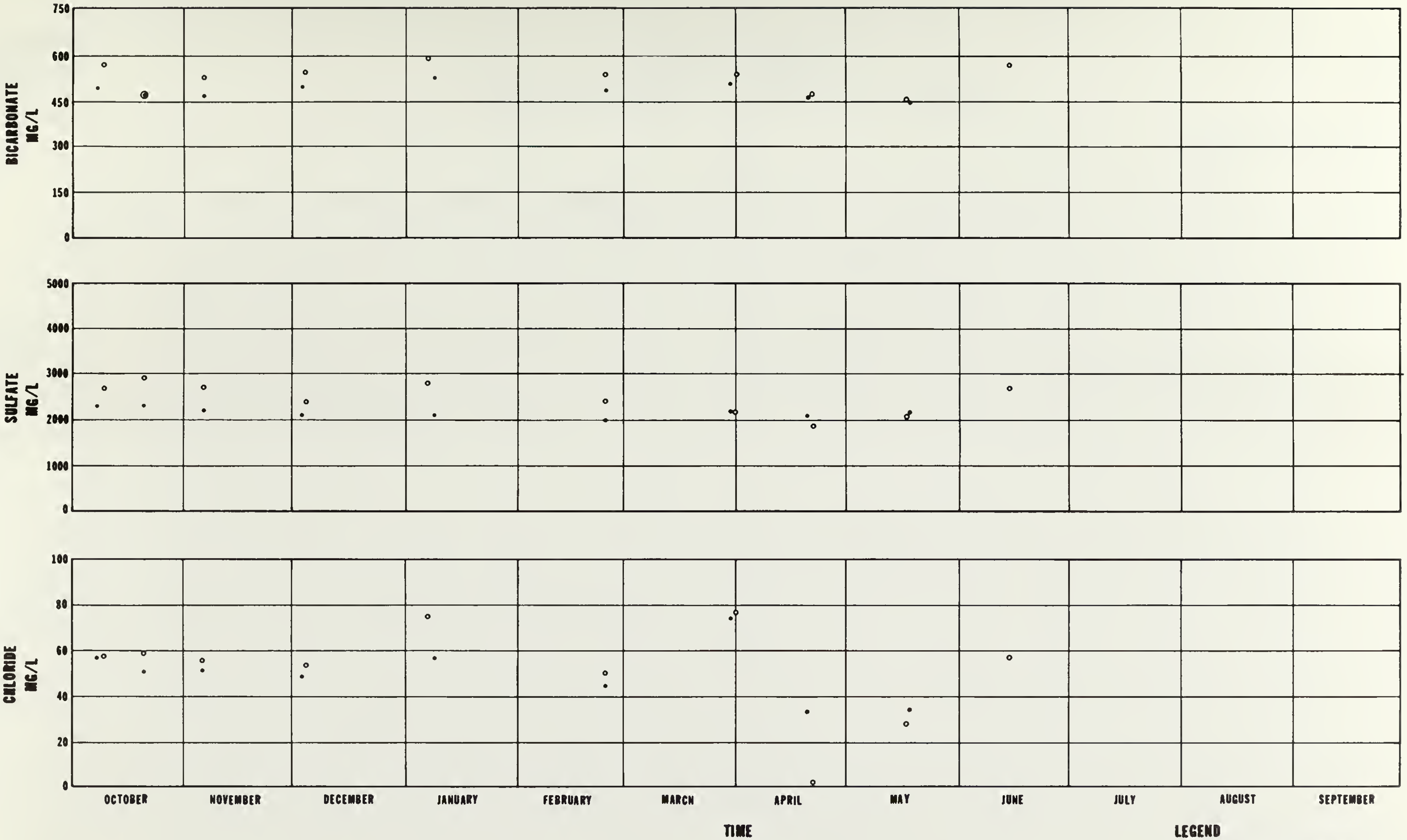


VARIATION IN TIME OF MAJOR CATIONS

EVACUATION CREEK NEAR MOUTH (S-2) AND EVACUATION CREEK AT WATSON, UTAH (S-6)

OCTOBER 1975 - SEPTEMBER 1976

FIGURE II-10



LEGEND

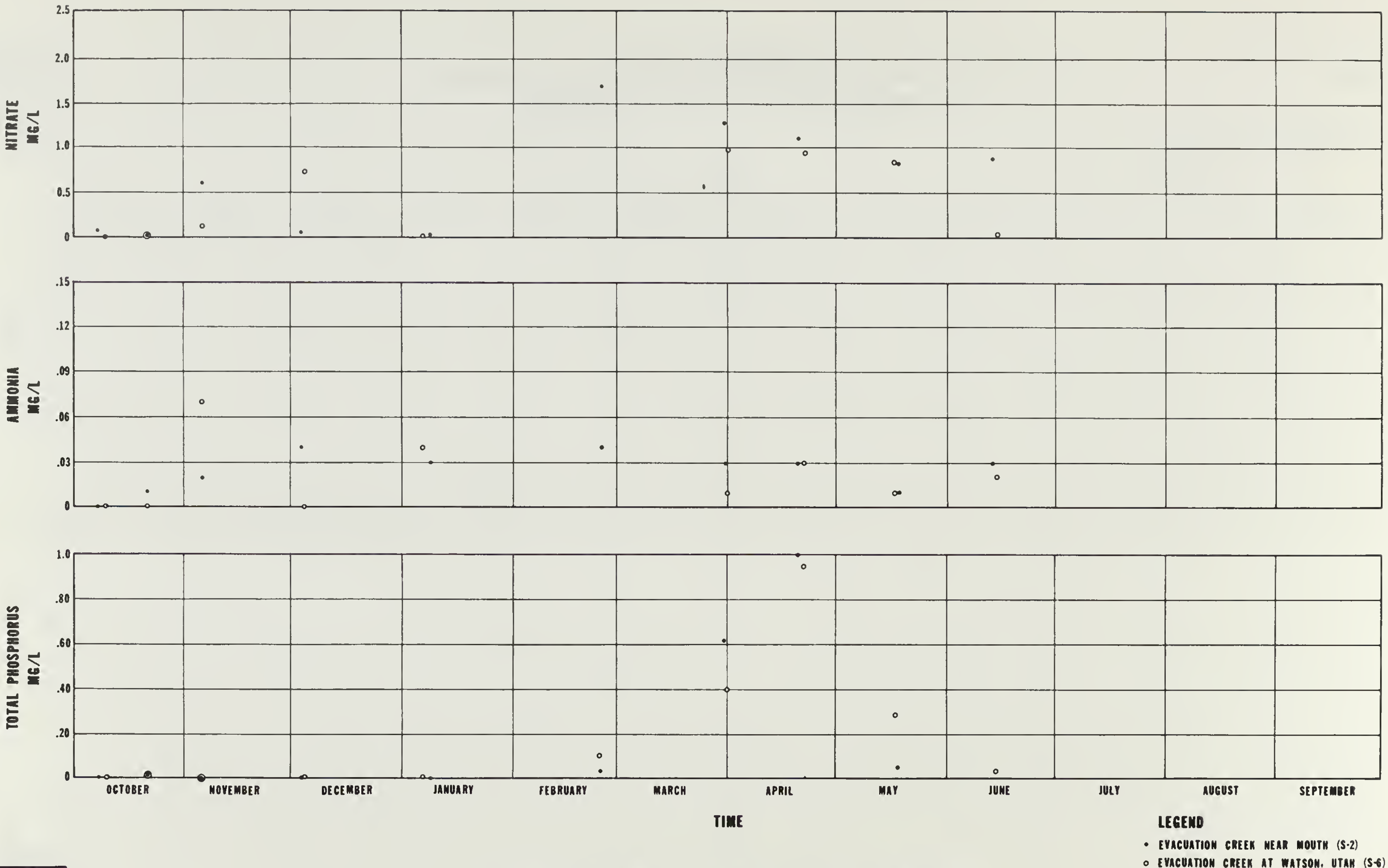
- • EVACUATION CREEK NEAR MOUTH (S-2)
- ○ EVACUATION CREEK AT WATSON, UTAH (S-6)

VARIATION IN TIME OF MAJOR ANIONS

EVACUATION CREEK NEAR MOUTH (S-2) AND EVACUATION CREEK AT WATSON, UTAH (S-6)

OCTOBER 1975 - SEPTEMBER 1976

FIGURE II-11

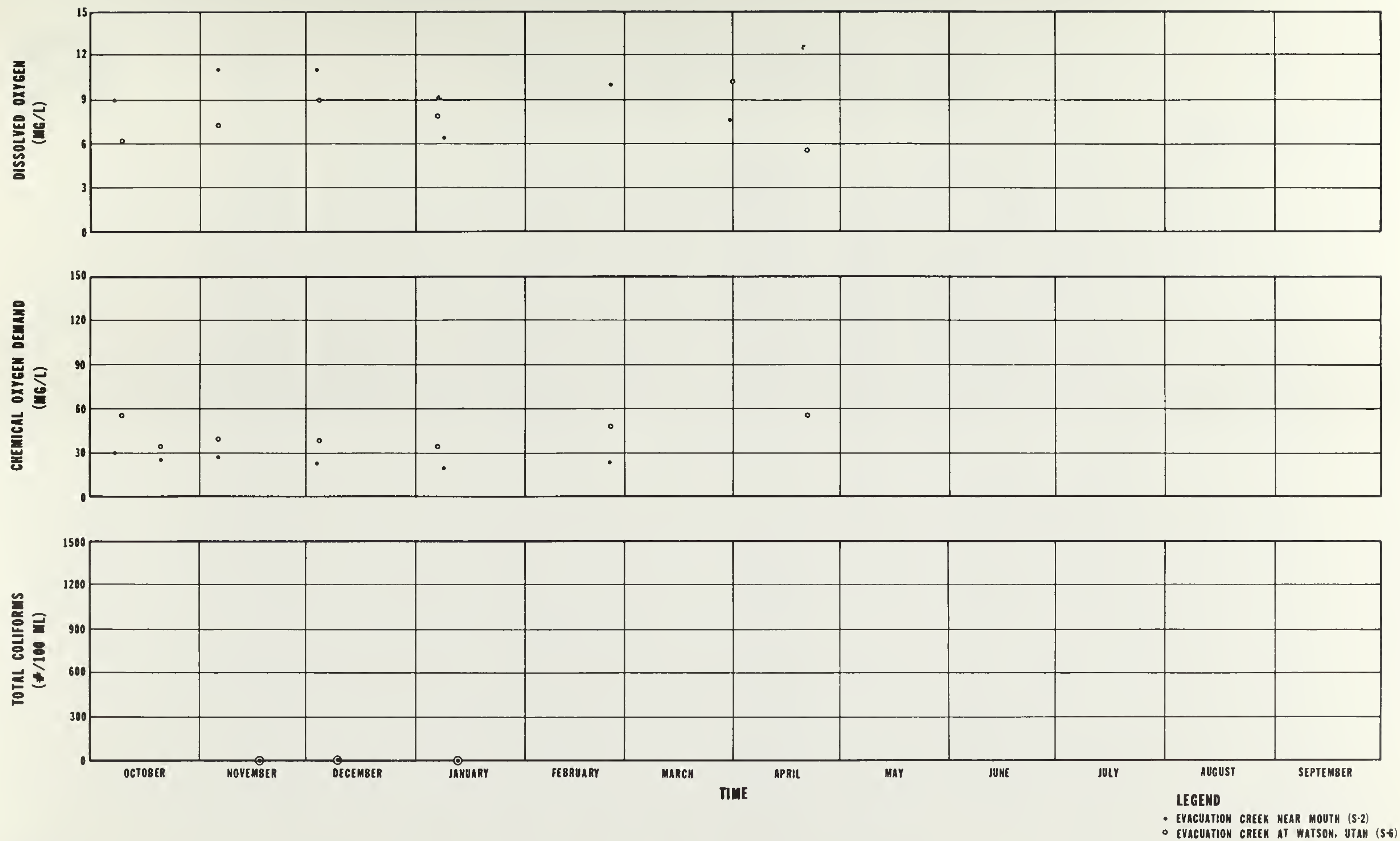


VARIATION IN TIME OF REPRESENTATIVE NUTRIENTS

EVACUATION CREEK NEAR MOUTH (S-2) AND EVACUATION CREEK AT WATSON, UTAH (S-6)

OCTOBER 1975 - SEPTEMBER 1976

FIGURE II-12

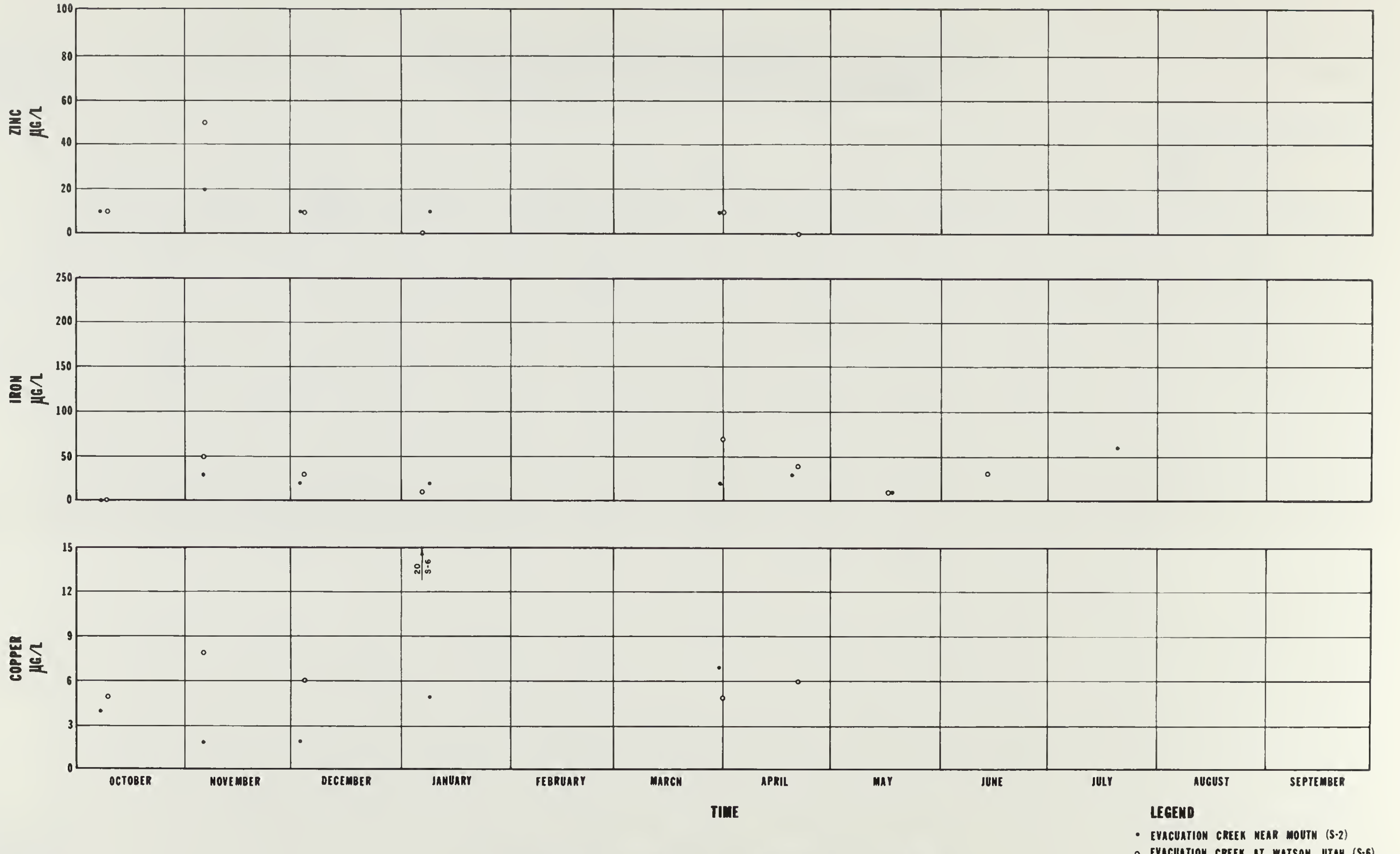


VARIATION IN TIME OF BIOCHEMICAL CONSTITUENTS

EVACUATION CREEK NEAR MOUTH (S-2) AND EVACUATION CREEK AT WATSON, UTAH (S-6)

OCTOBER 1975 - SEPTEMBER 1976

FIGURE II-13



VARIATION IN TIME OF SOME TRACE ELEMENTS

EVACUATION CREEK NEAR MOUTH (S-2) AND EVACUATION CREEK AT WATSON, UTAH (S-6)

OCTOBER 1975 - SEPTEMBER 1976

FIGURE II-14

averaged 199 mg/l.) All were definately calcium-sodium-bicarbonate type of water.

b. Precipitation

Data from the precipitation-quality program instituted in January indicates that the precipitation is nearly pure. Dissolved solids ranged from 6 mg/1 to 10 μg/1. Because of the low dissolved solids the laboratory did not run the trace-element analysis. Also, the major ions varied so widely from one sample to another that it is not clear whether they actually vary or whether the discrepancies are caused by the inevitable sample contamination from dust on the collection surface.

3. GROUND WATER LEVEL MONITORING

Hydrographs constructed from monthly static water level records are shown on Figure II-15; hydrographs constructed from the continuous recording wells are shown on figures II-16, II-17, II-18 and II-19.

4. GROUND WATER QUALITY

The computer print out for some bedrock and alluvial well samples collected from November 1975 through June 1976 has been received. Lab sheets for some of the alluvial well samples have been received. The available data from the print out are included in the field-data report.

C. WORK SCHEDULED

1. SURFACE WATER HYDROLOGY

Baseline monitoring will be completed September 31, 1976. Subject to AOSO approval an interim monitoring program will be implemented effective October 1, 1976.

2. SURFACE WATER QUALITY

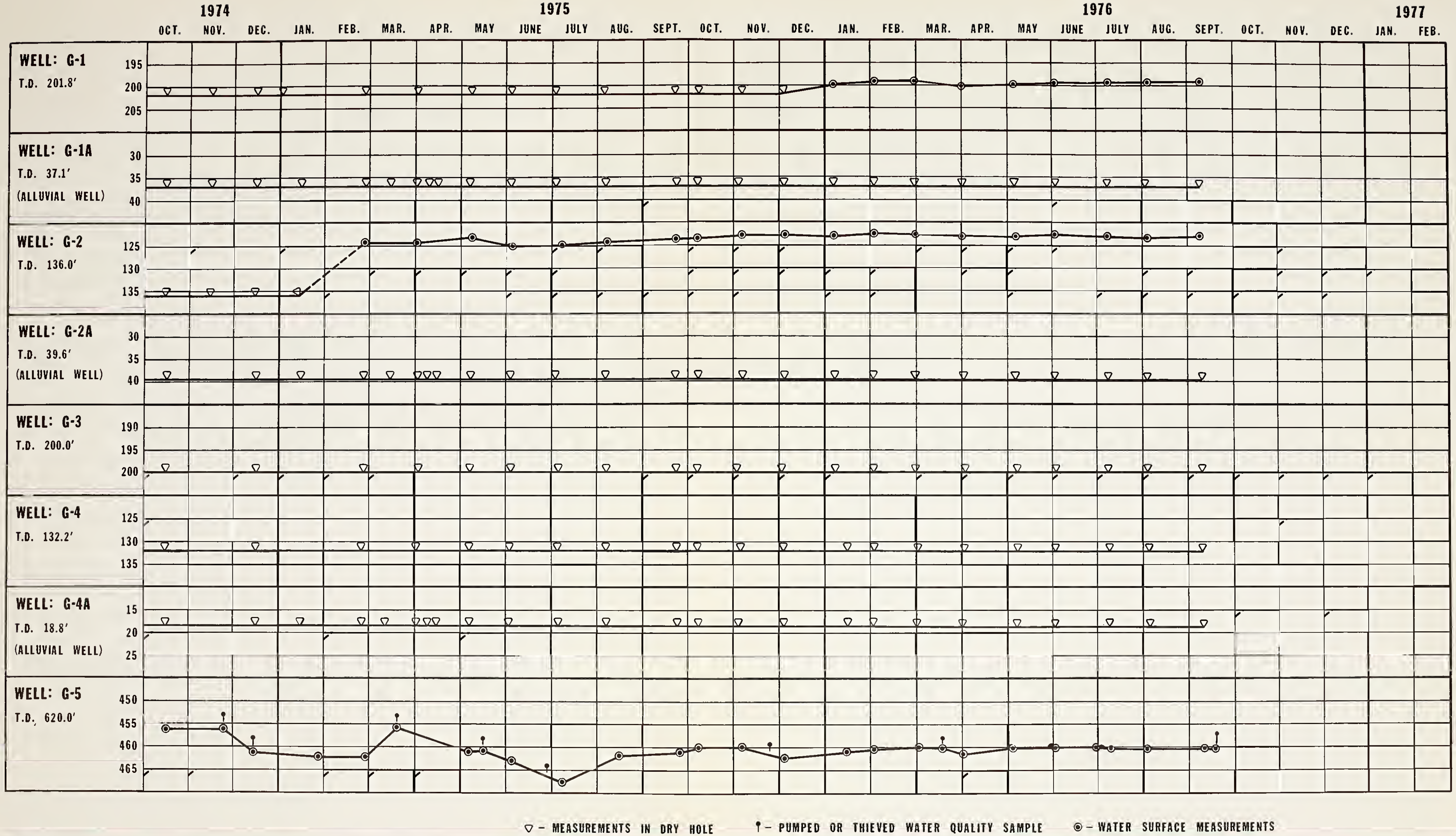
The water quality program will follow the same schedule as the surface water hydrology.

3. GROUND WATER LEVEL MONITORING

Monthly and static water level monitoring will continue.

4. GROUND WATER QUALITY

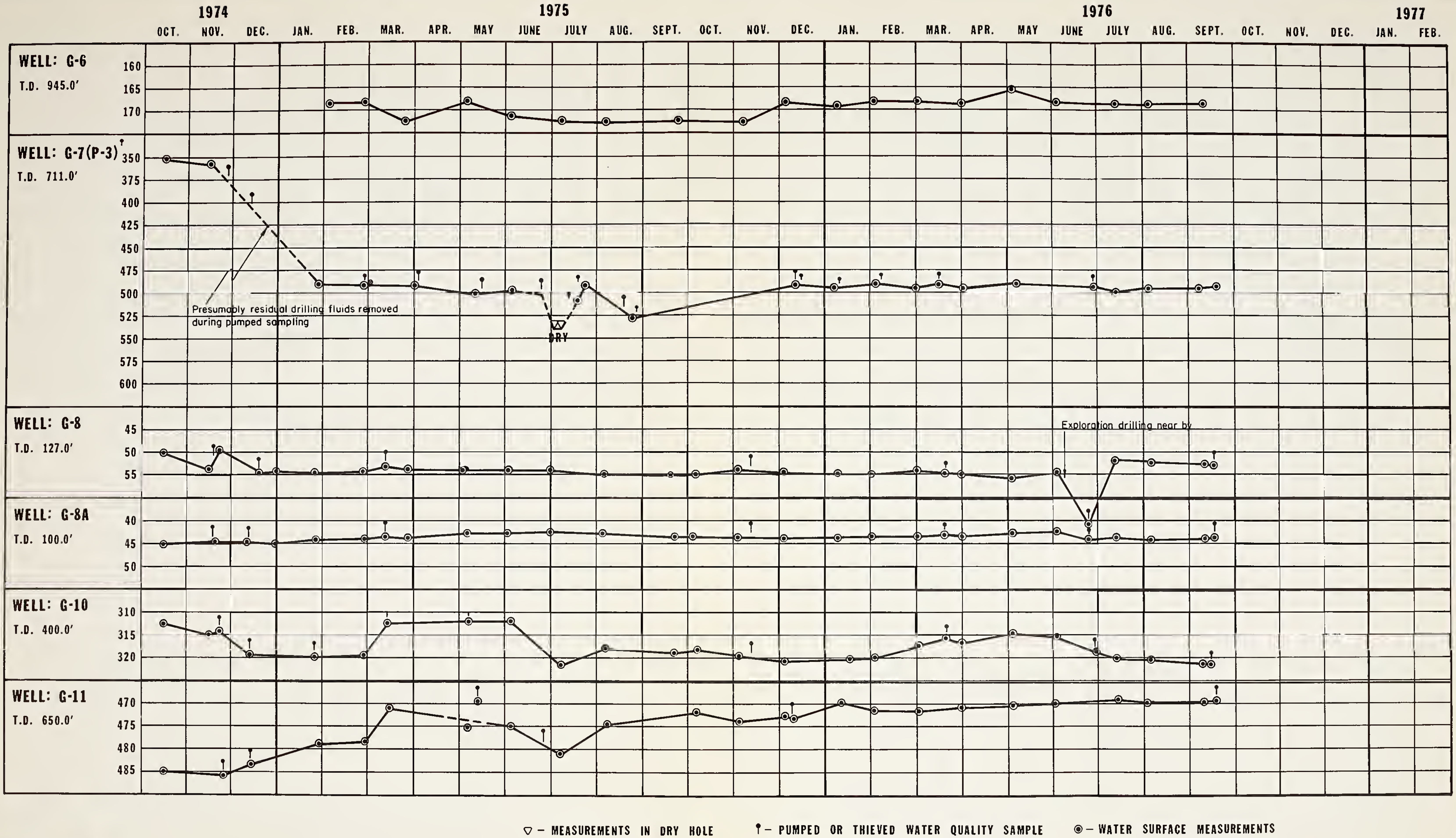
As per the revised Conditions of Approval, the alluvial well sampling program was completed in August. Quarterly samples will be collected from the quarterly bedrock wells in September.



MONTHLY MEASURED STATIC WATER LEVELS IN WELLS

WHITE RIVER SHALE PROJECT TRACTS Ua & Ub

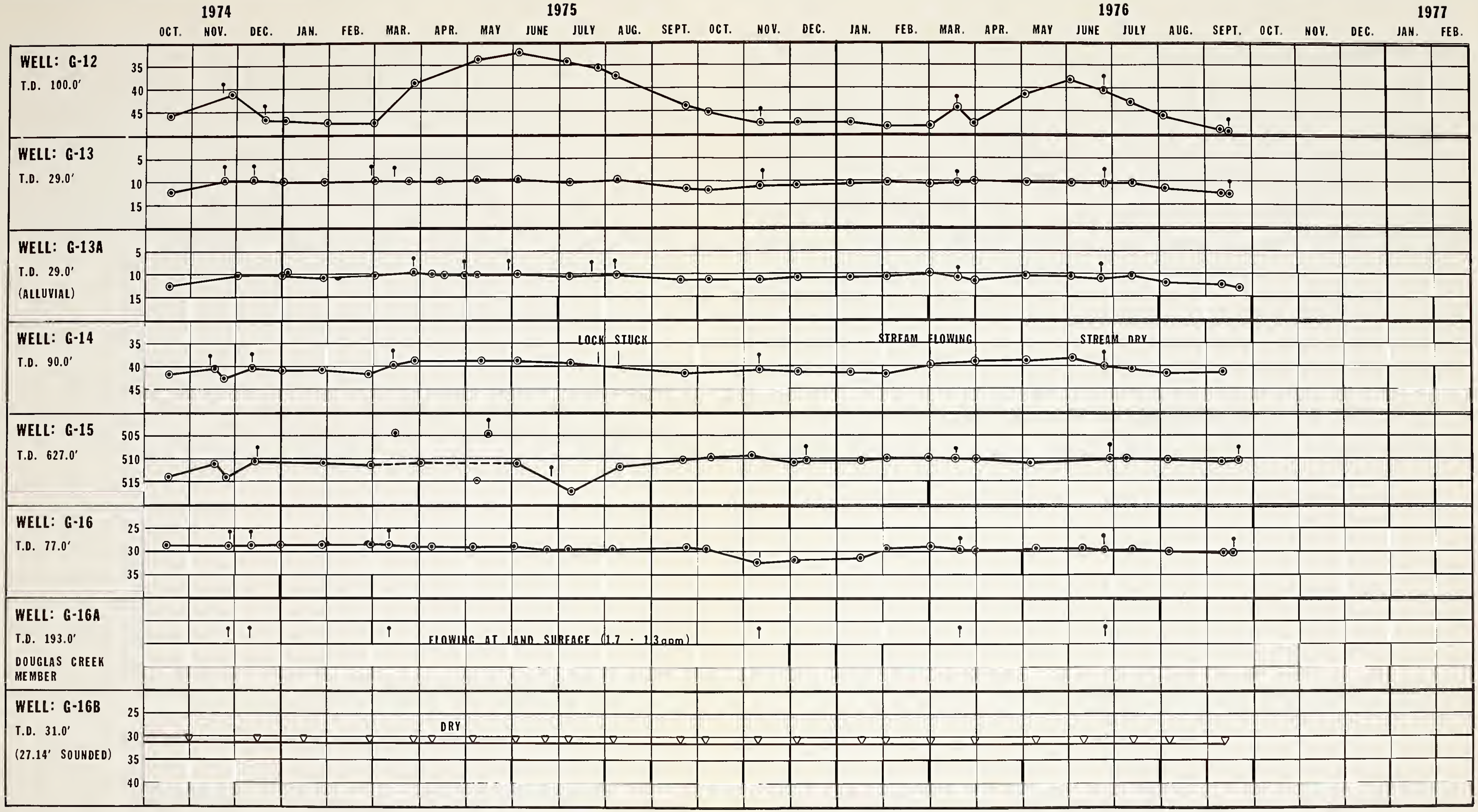
FIGURE II-15



MONTHLY MEASURED STATIC WATER LEVELS IN WELLS

WHITE RIVER SHALE PROJECT TRACTS Ua & Ub

FIGURE II-15 (CON'T)

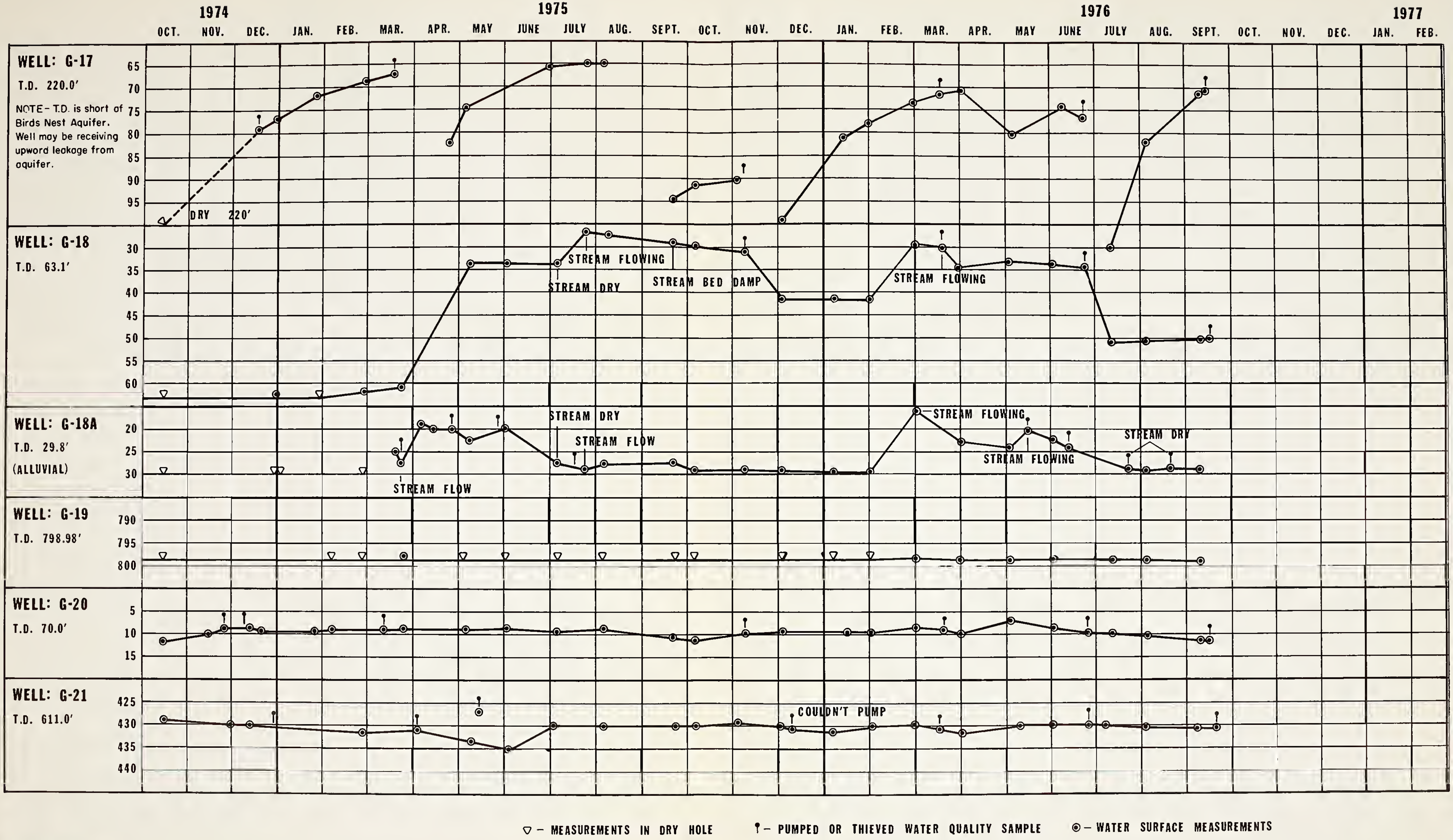


▽ – MEASUREMENTS IN DRY HOLE ↑ – PUMPED OR THIEVED WATER QUALITY SAMPLE ⊙ – WATER SURFACE MEASUREMENTS

MONTHLY MEASURED STATIC WATER LEVELS IN WELLS

WHITE RIVER SHALE PROJECT TRACTS Ua & Ub

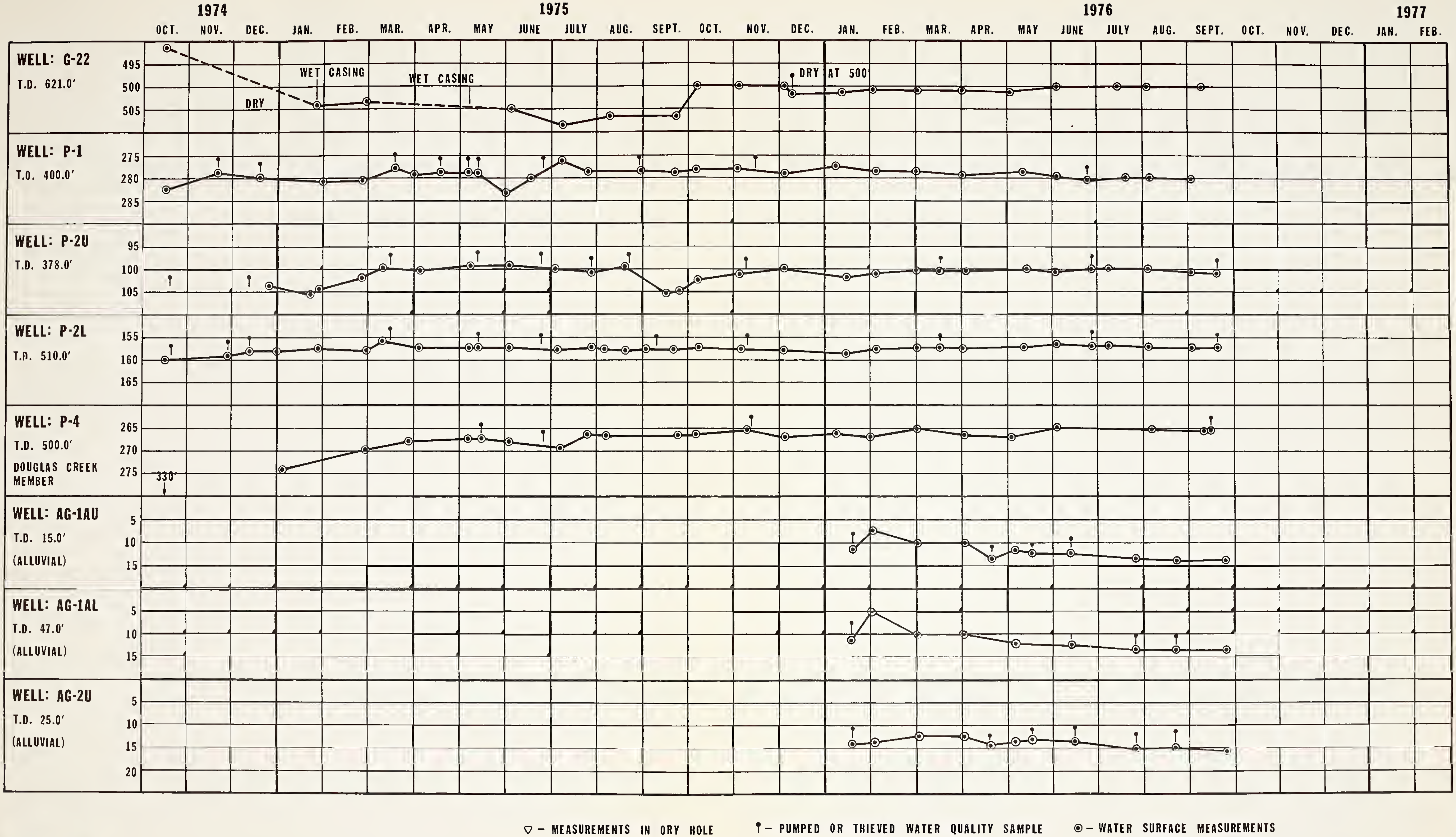
FIGURE II-15 (CON'T)



MONTHLY MEASURED STATIC WATER LEVELS IN WELLS

WHITE RIVER SHALE PROJECT TRACTS Ua & Ub

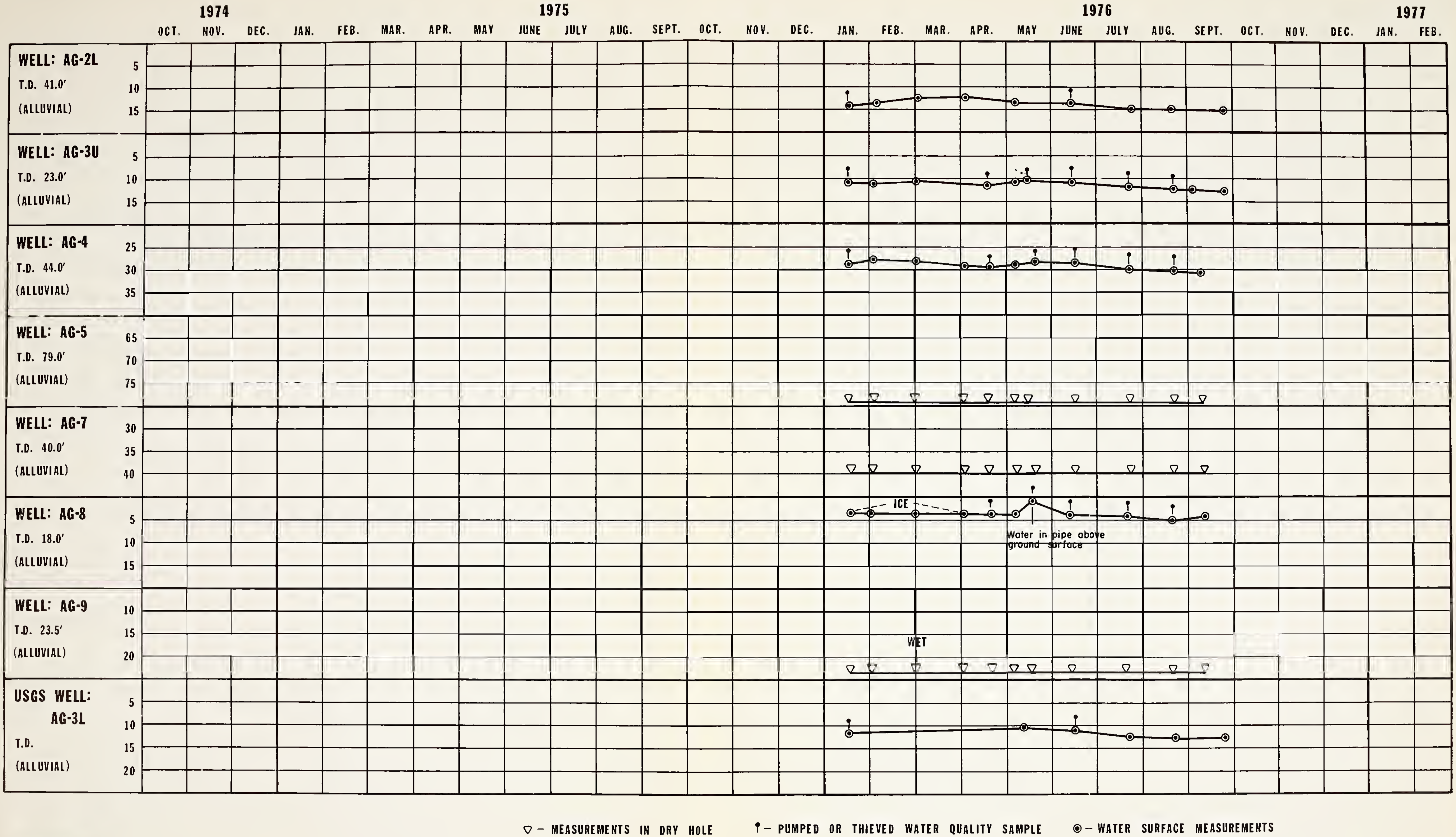
FIGURE II-15 (CON'T)



MONTHLY MEASURED STATIC WATER LEVELS IN WELLS

WHITE RIVER SHALE PROJECT TRACTS Ua & Ub

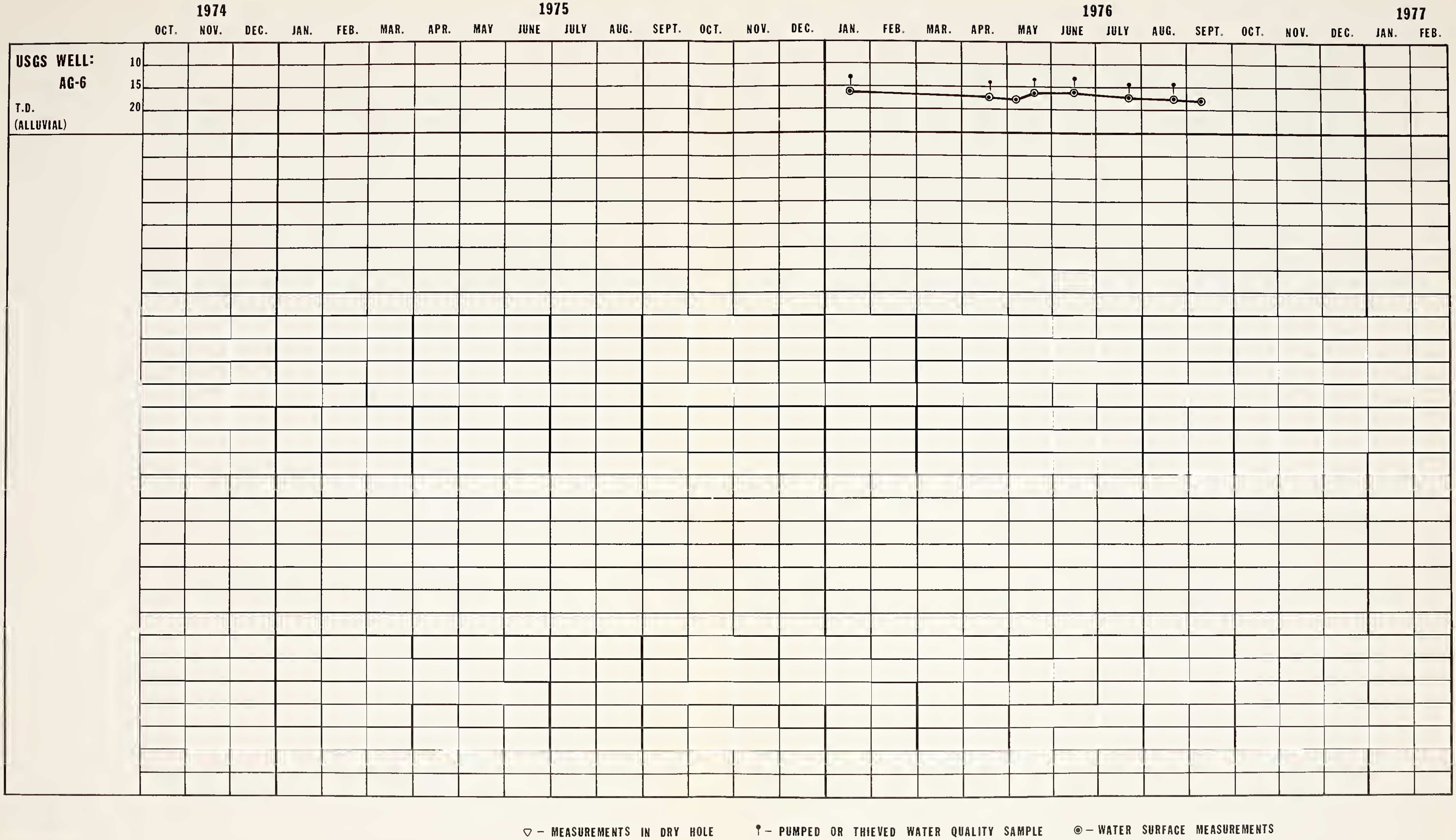
FIGURE II-15 (CON'T)



MONTHLY MEASURED STATIC WATER LEVELS IN WELLS

WHITE RIVER SHALE PROJECT TRACTS Ua & Ub

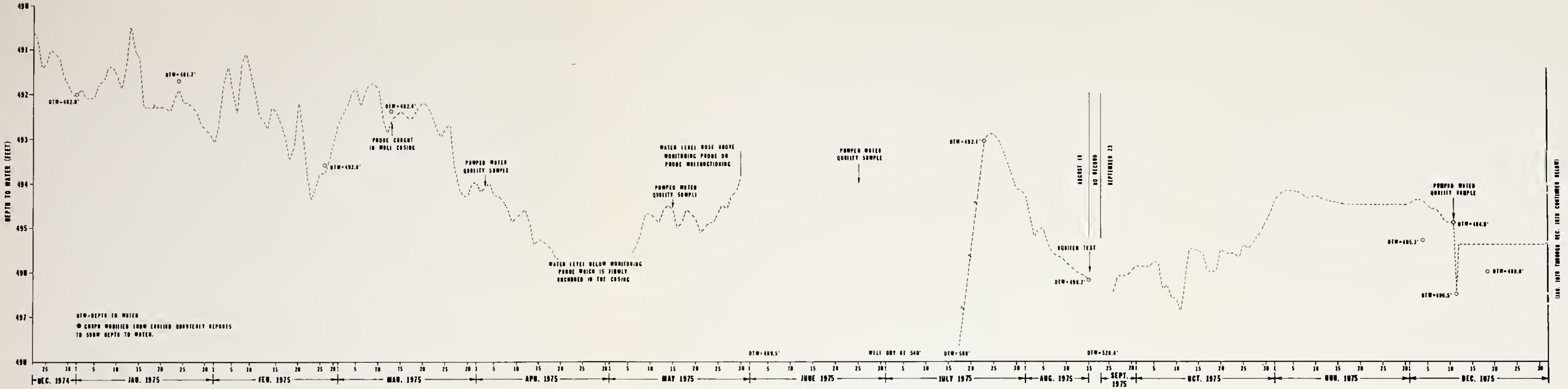
FIGURE II-15 (CON'T.)



MONTHLY MEASURED STATIC WATER LEVELS IN WELLS

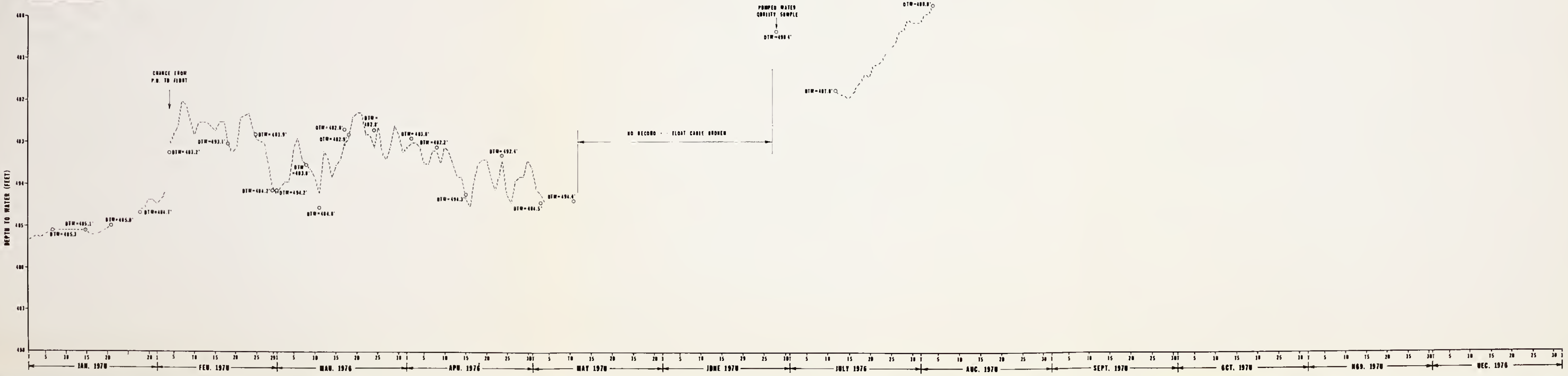
WHITE RIVER SHALE PROJECT TRACTS Ua & Ub

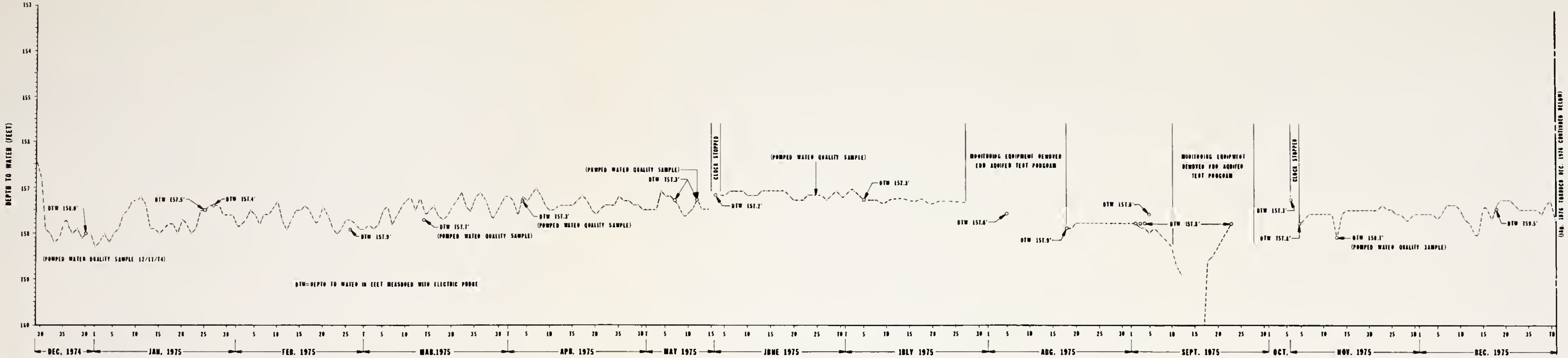
FIGURE II-15(CON'T)



CONTINUOUS MONITORING WELL G-7*
(SURFACE ELEVATION 5486.0')

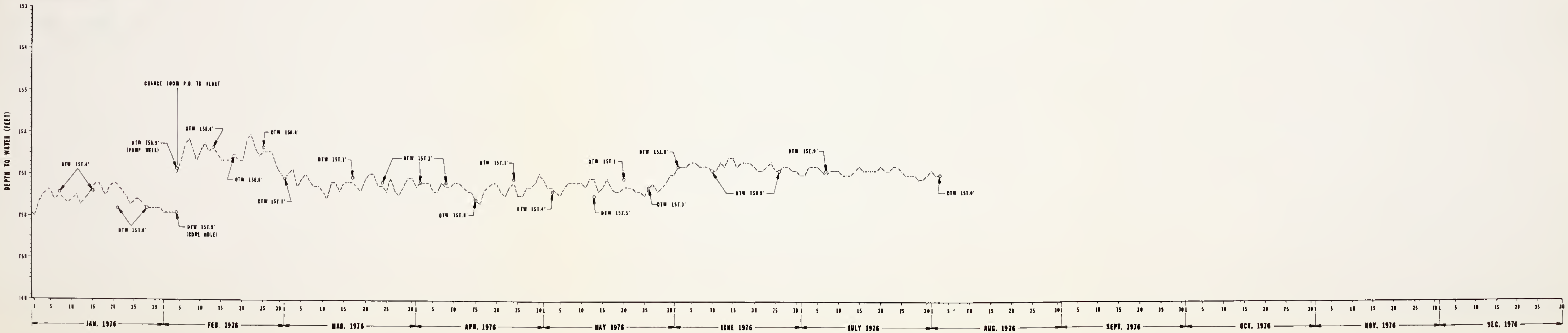
FIGURE II-16

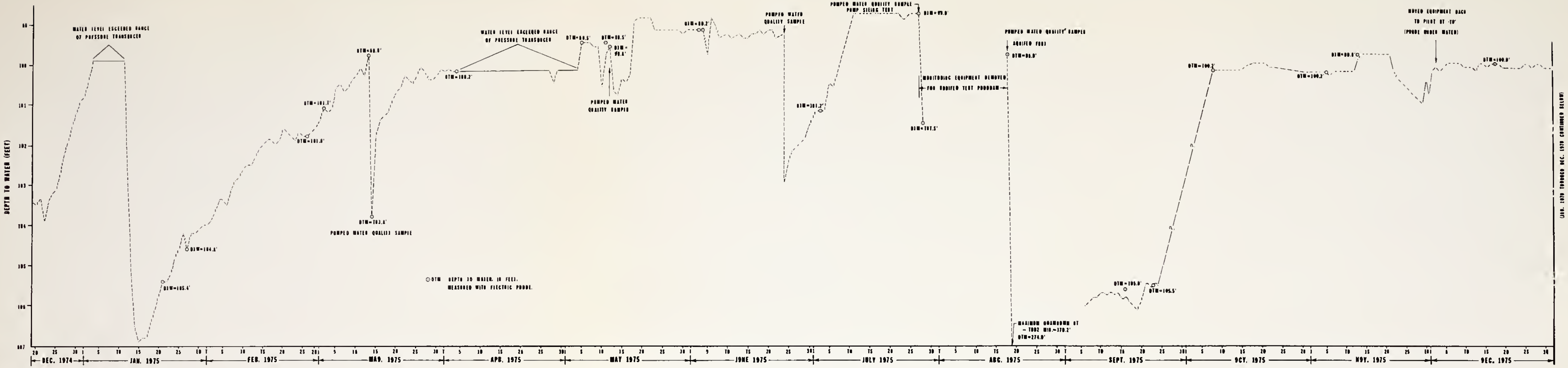




CONTINUOUS MONITORING WELL P-2 LOWER
(SURFACE ELEVATION 4991.0')

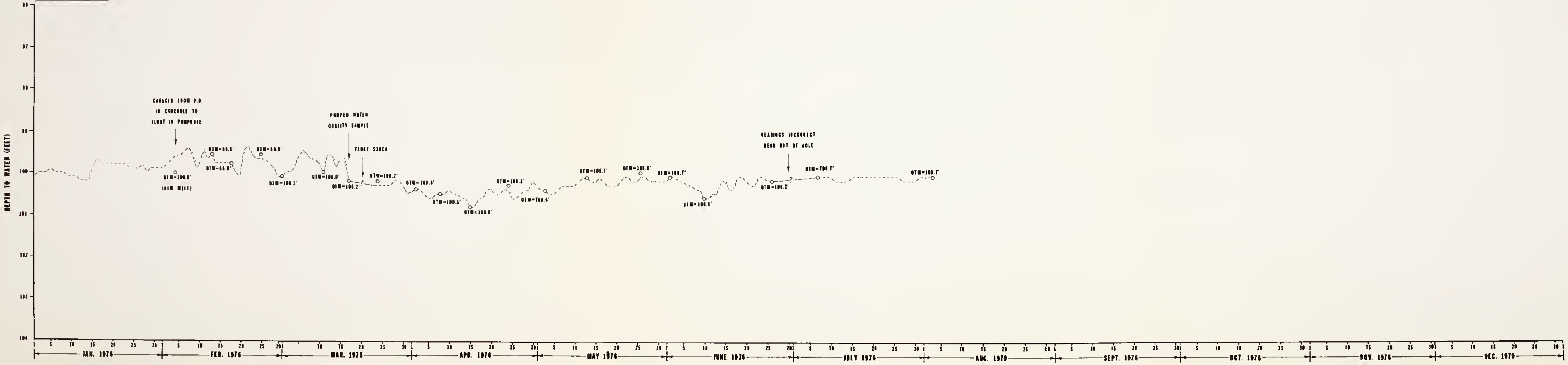
FIGURE II-17

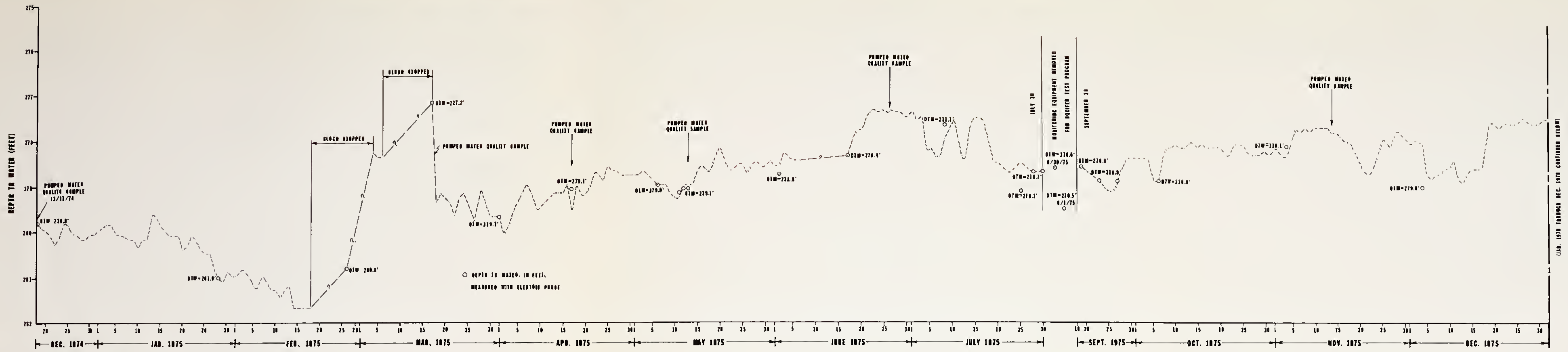


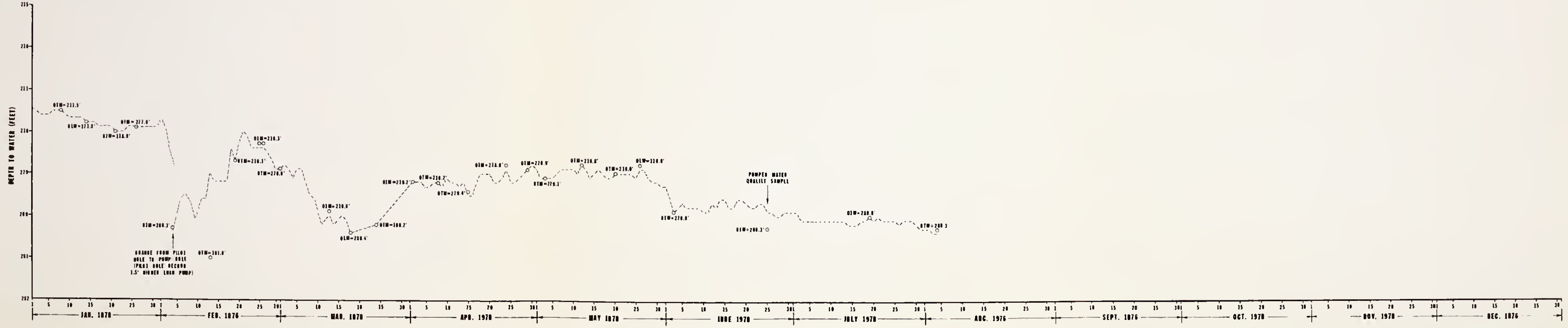


CONTINUOUS MONITORING WELL P-2 UPPER
(SURFACE ELEVATION 4991.0')

FIGURE II-18







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CONTINUOUS MONITORING WELL P-1

(SURFACE ELEVATION 5284.0')

FIGURE II-19

III. AIR RESOURCES

A. WORK COMPLETED

During the quarter ending August 31, 1976, meteorology, air quality, and radiation were monitored according to the modified stipulations and conditions for the second year of baseline data collection, as authorized by the Area Oil Shale Supervisor April 14. The parameters monitored on the tracts are tabulated by station on Table III-1. In addition to these parameters, samples were collected once a month at Station A-2 for trace-metal analysis, visibility surveys were conducted once a month at Station A-9, and radiation was monitored at stations A-1 through A-12. One high-volume sampler filter per month from Station A-6 was also analyzed for gross alpha and beta radiation levels and for isotope gamma radiation.

All measurement activities continued as established in the modifications. Comprehensive calibrations of all air monitoring instruments were performed in August, and all sulfur analyzers were calibrated in mid-June. In addition to the regular quarterly calibrations of the gaseous pollutant analyzers and the twice-annual high-volume sampler calibrations, zero and span checks are made for most air-quality monitoring instruments once every three days.

The data collected from May 1, 1976, through July 3, 1976, are tabulated on Table III-2. (Data processing lead times result in a one-month offset from the June - August quarter reporting period for most of the data in this discussion.) The table lists the percentage of hours during the period that data collection was underway for each parameter. Calibration time is counted as data-collection time. Only those parameters specifically listed in the leases (or implied therein) are tabulated. The leases state that "...the Lessee shall monitor air quality over at least 90 percent of each lease year...Table III-2 shows that air quality monitoring took place 100% of the May - July period, while each of the specified parameters was monitored 100% of the hours of this period. For meteorology, the leases state that, "... the Lessee shall establish a meteorological station ...to monitor, at least 95 percent of the time over each lease year..." Again, meteorology was monitored 100% of the May - July period at a number of stations, well in excess of the one per tract specified in the leases, and monitoring of any given parameter was performed 100% of the hours of the quarter.

TABLE III-1

AIR RESOURCES PARAMETERS MEASURED BEGINNING MAY 1976.

Parameters Measured \ Sites	A-2	A-3	A-4	A-6	A-7	A-10	A-11	A-13
WS-WD 10 m	X	X	X	X	X	X	X	X
WS-WD 20 m	X			X				
WS-WD 30 m	X			X				
Temp. 10 m	X		X	X		X	X	X
Δ Temp. (30-10 m)	X			X				
Humidity	X			X				
σ_θ, σ_W -10 m			X					
σ_θ, σ_W -30 m	X			X				
Pressure				X				
Net Radiation				X				
SO_2		X	X	X	X			
H_2S		X	X	X	X			
TS		X	X	X	X			
CO				X				
HC				X				
CH_4				X				
O_3				X				
NO_2				X				
Part.		X	X	X	X			
Scat. Coeff.	X							

TABLE III-2

PERCENTAGE OF TIME MONITORING WAS PERFORMED
DURING THE PERIOD MAY 1 - JULY 31, 1976.

Component	Number of Stations	Percentage
H_2S	4	100
SO_2	4	100
Susp. Particulates	4	100
HC	1	100
NO_x	1	100
O_3	1	100
Wind (10 m)	8	100
Wind (20 m)	2	100
Wind (30 m)	2	100
Temp. (10 m)	6	100
Δ Temp. (30-10 m)	2	100
Rel. Hum.	2	100

B. DATA SUMMARY

In general, conditions observed on the tracts during this period compare well with those for the comparable period in 1975.

1. METEOROLOGY

a. Surface Meteorology

Typical airflow patterns observed on the tracts during the early morning (0400-0600 MST) and afternoon (1400-1600 MST) in this quarter are seen on figures III-1 and III-2. The solid arrows are wind vectors at monitoring sites, and the longer lines are estimated flow streamlines. In the early morning hours, airflow was of the drainage type, flowing toward low terrain and down the White River channel, as has been observed throughout the monitoring program. The afternoon winds were more organized and were dominated by the synoptic scale pressure gradient. A general west-to-east airflow pattern can be recognized throughout the tracts.

The diurnal variation of mean wind speed and its standard deviation at Station A-6 in July are plotted on Figure III-3. Higher winds were observed in the afternoon and lower winds at night. In the afternoon, windspeeds averaged around 5.5 m/s (12 mph) and at night, about 2.5 m/s (5.5 mph).

Figure III-4 shows directional wind roses at all wind stations on the tracts. The predominance of drainage types of winds is clearly shown. Spatial variation in wind speed and wind direction over the tracts, a result of the complex terrain features in the area, is evident in figures III-1, III-2 and III-4. Generally, wind speeds over the ridges and widely exposed terrain were higher than wind speeds in protected valleys.

Figure III-5 shows the diurnal variation in temperature in July at Station A-6. Average nighttime values were around 17 C, and average afternoon values were around 30 C. The daily maximum temperature was generally at 1400-1600 MST, and the daily minimum temperature was between 0500-0700 MST. On the tracts, temperatures were usually lower in protected valleys than in open terrain.

A plot of the diurnal variation in relative humidity in July at Station A-6 is shown on Figure III-6. Nighttime relative humidity was about 22%. This diurnal trend is

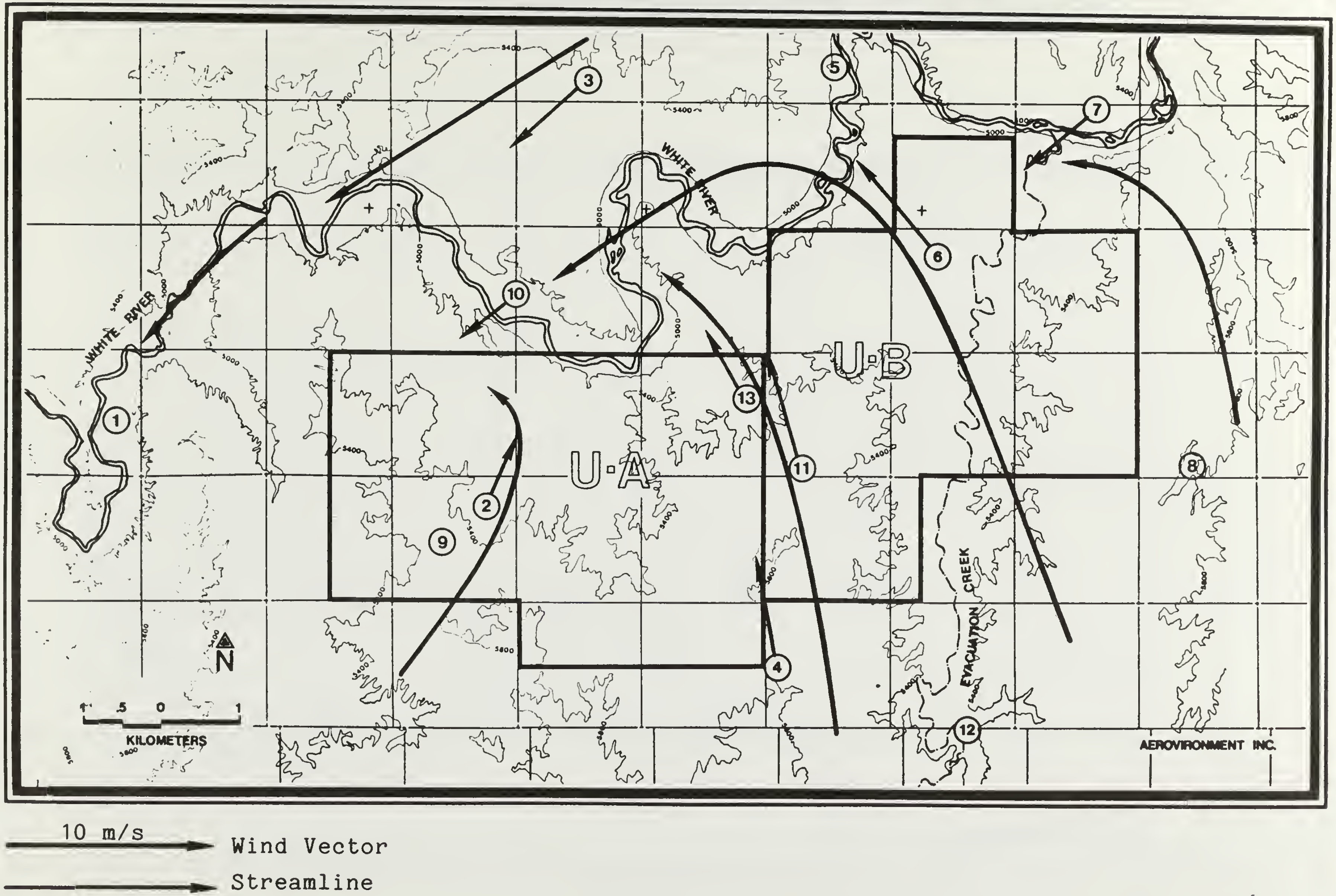
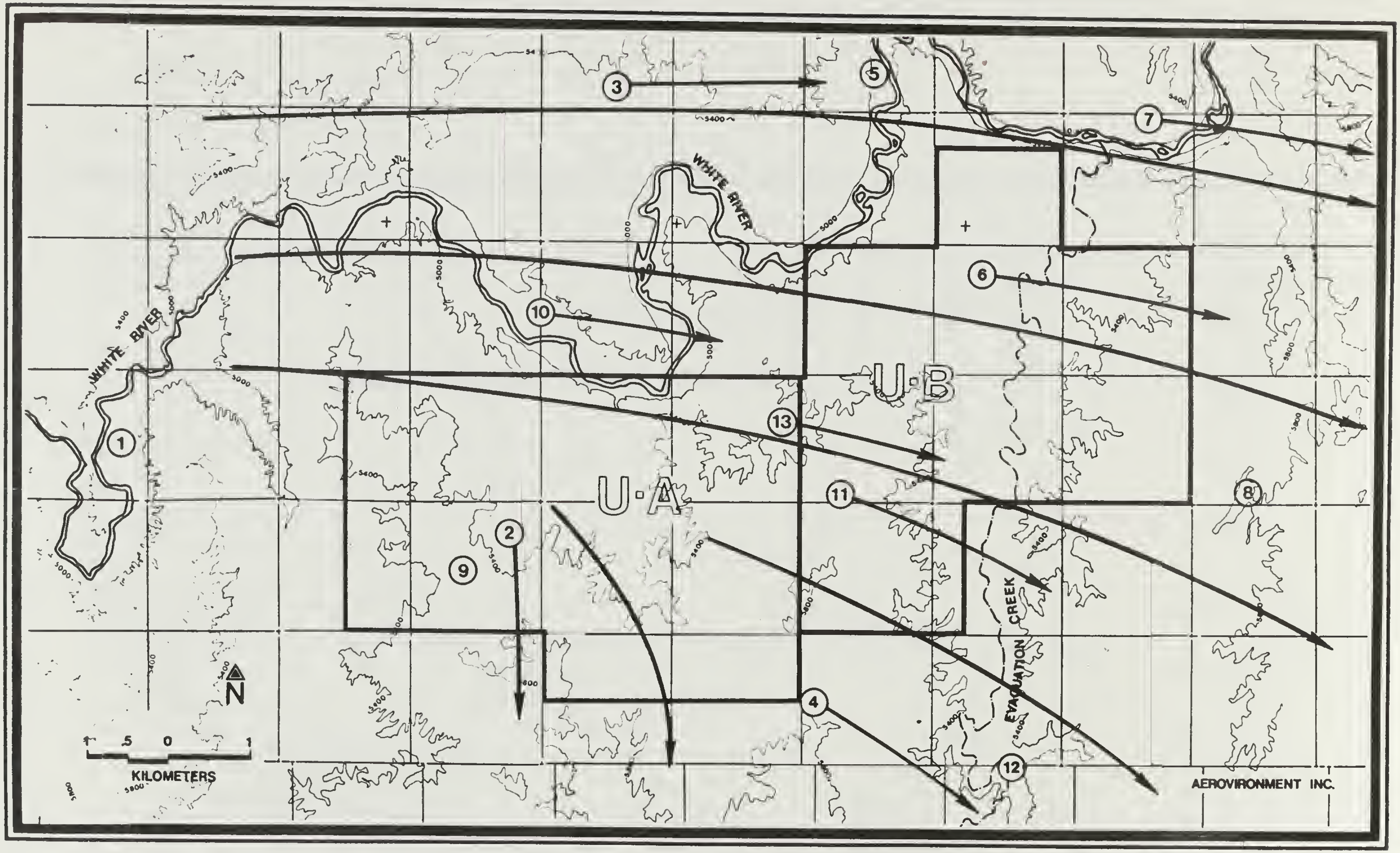


FIGURE III-1. TYPICAL AIRFLOW PATTERN ON TRACTS UA AND UB ON THE MORNING OF JULY 1976.



10 m/s

Wind Vector

Streamline

FIGURE III-2. TYPICAL AIRFLOW PATTERN ON TRACTS UA AND UB ON THE AFTERNOON OF JULY 1976.

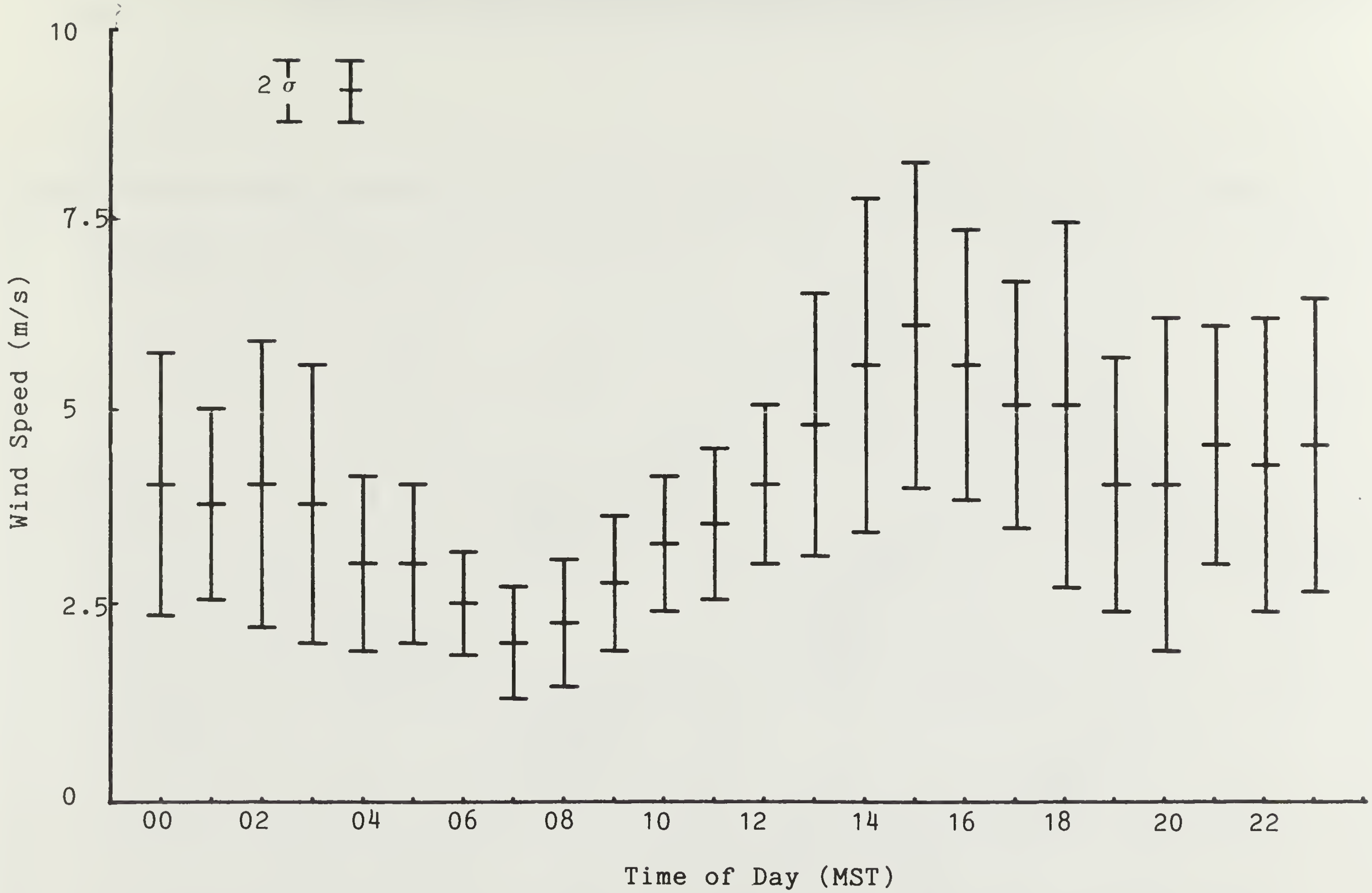


FIGURE III-3. DIURNAL VARIATION OF MEAN WIND SPEEDS AND THEIR STANDARD DEVIATION AT STATION A-6 IN JULY 1976, A TYPICAL SUMMER MONTH. (1 m/s = 2.24 mph)

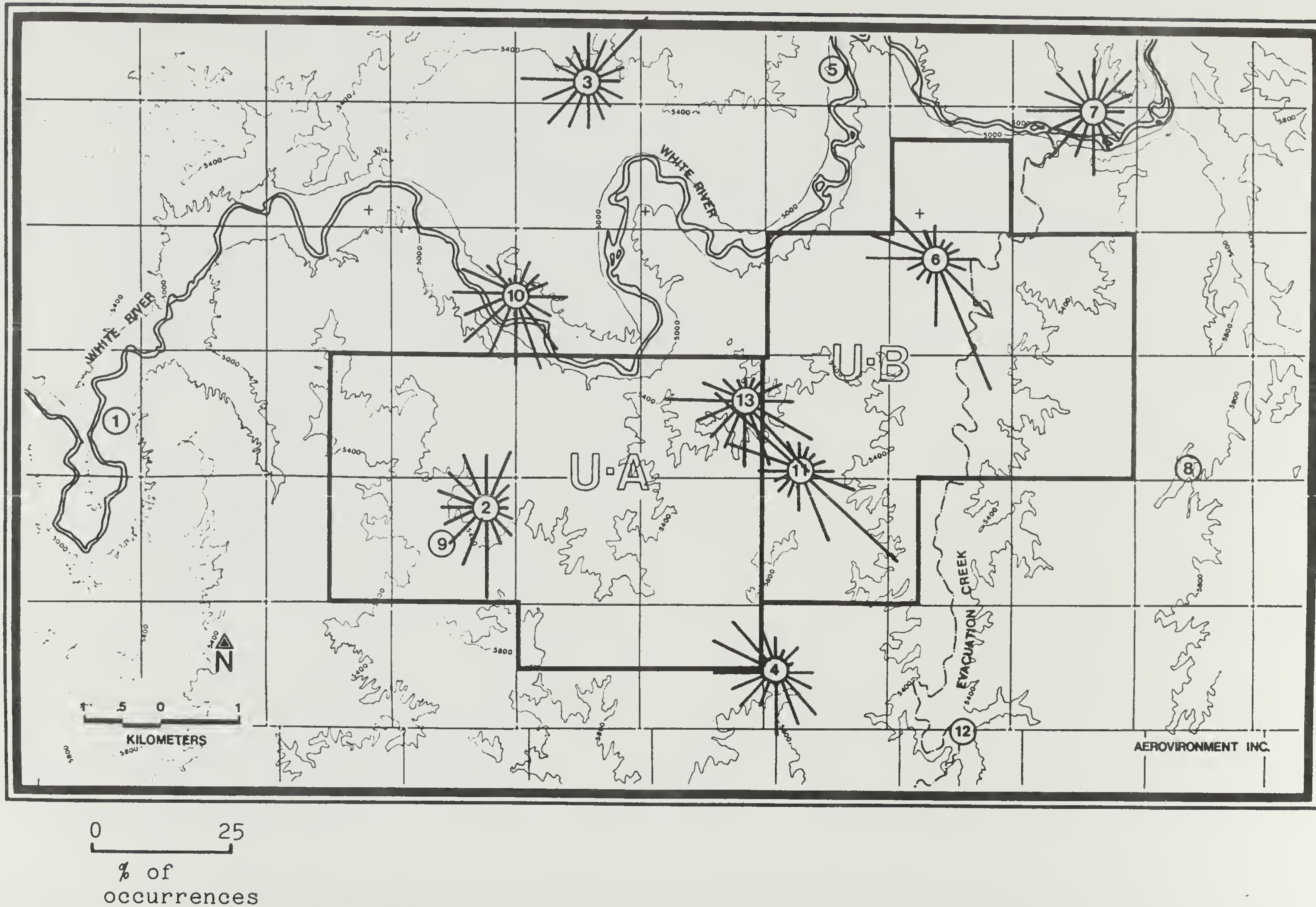


FIGURE III-4. DIRECTIONAL WIND ROSES AT THE MONITORING STATIONS ON THE TRACTS FOR JULY 1976. The length of each bar represents the frequency of winds from the direction toward which the bar points.

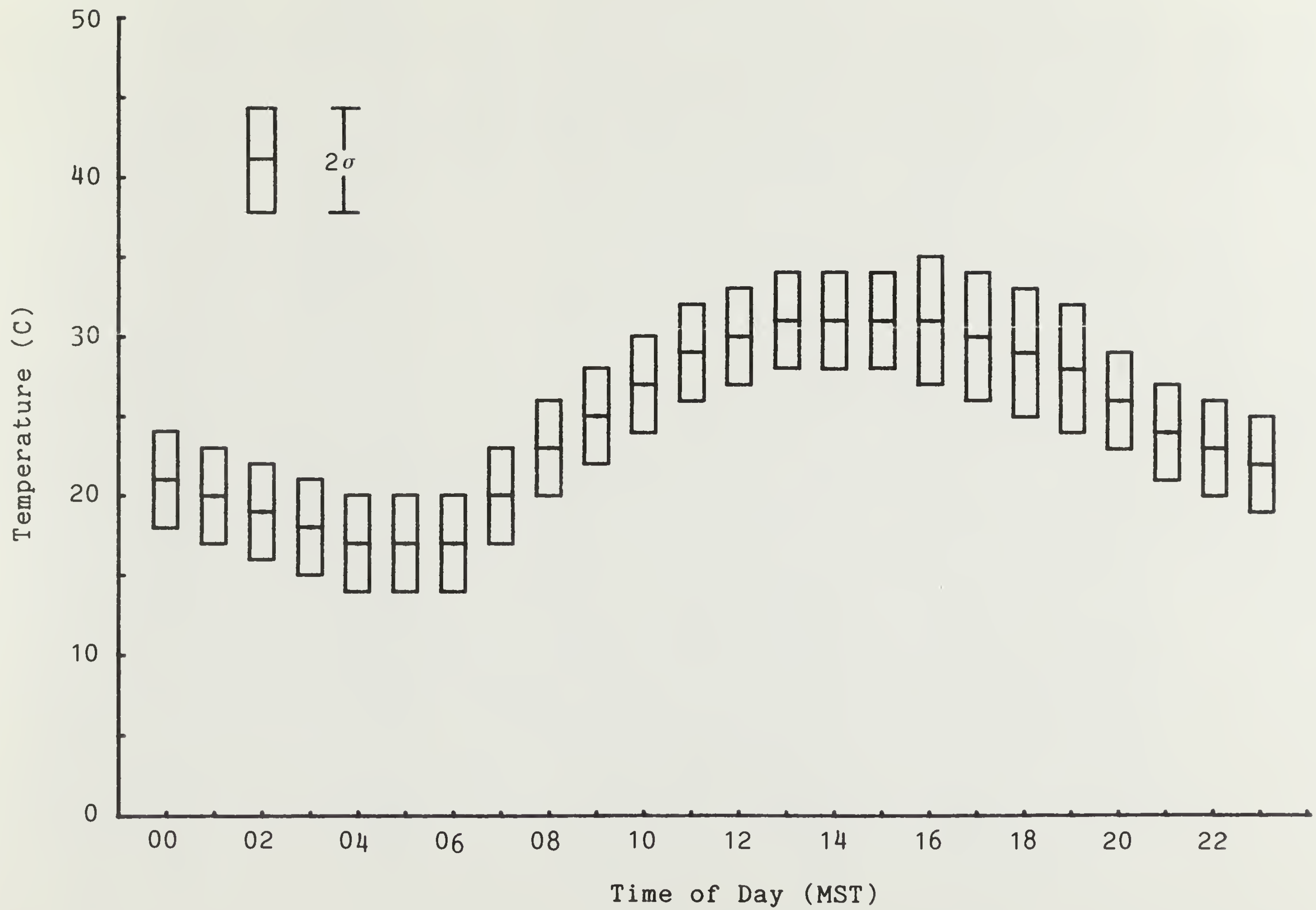


FIGURE III-5. DIURNAL VARIATION OF MEAN TEMPERATURES AND THEIR STANDARD DEVIATIONS AT STATION A-6 IN JULY.

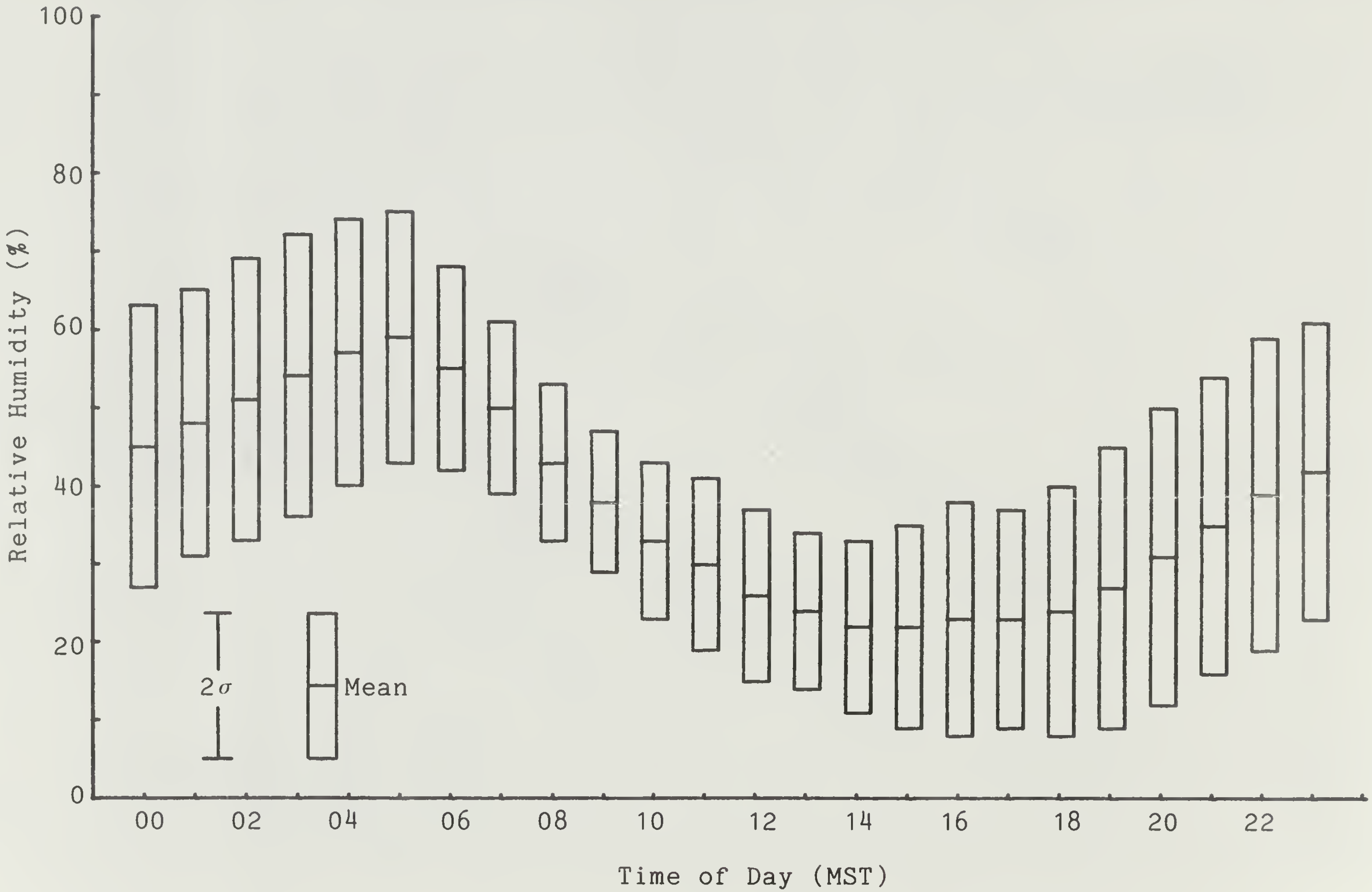


FIGURE III-6. DIURNAL VARIATION OF MEAN RELATIVE HUMIDITY READINGS AND THEIR STANDARD DEVIATIONS AT STATION A-6 IN JULY.

a mirror image of the temperature plot on Figure III-5, which indicates that the amount of water vapor in the air remains constant during the day.

b. Normality of Measurement Period

The normality of meteorological conditions on the tracts is deduced by a comparison of rawinsonde data collected by the National Weather Service at Grand Junction during the monitoring program with corresponding historical meteorological records. Since there is a six-month delay between the collection of upper-air data at Grand Junction and public release of the data, it is not possible to test the normality of the most recent quarter. Instead, the months of January, February, and March 1976 were tested, continuing the pattern of the preceding quarterly reports.

Comparisons of meteorological data at 700 mb, the first standard barometric level above all of the terrain at Grand Junction and the tracts, are given on Table III-3. These comparisons show that the average wind speed in February was about 1 m/s to 2 m/s lower than the ten-year norm. Also, the average temperature in February was about 3 C lower than the corresponding ten-year average. Except for these short-term deviations, meteorological conditions in January through March at Grand Junction can be considered relatively normal, and by inference the conditions on the tracts during this period should have been relatively representative of their averages for these months.

2. DIFFUSIVITY

The dispersion or dilution of windborne effluents in the atmospheric boundary layer greatly depends on the turbulence intensity of the diffusivity of the atmosphere. This diffusivity on the tracts can be characterized by a number of routine meteorological measurements.

One approach to characterizing diffusivity is to compare temperatures at two surface stations in close proximity to each other but at different elevations. It was pointed out in the fourth quarterly report that qualitatively, the A-6 - A-2 temperature comparison shows the proper trends over the 1610-1628 m altitude range and the A-6 - A-4 pair shows the proper trends over the 1610-1754 m range. Figure III-7 shows the average temperatures and their standard deviations at stations A-2, A-4, and A-6 at 0500 and 1400

TABLE III-3

UPPER AIR DATA

Comparison of 700 mb. monthly average upper air data at Grand Junction, Colorado from January 1976 through March 1976 with their corresponding ten-year means. The 10-year norm, and the duration of current data from this norm, are tabulated.

	Morning (0500 MST) Soundings						Afternoon (1700 MST)Soundings					
	Wind Speed (m/s)		Temp (C)		Rel. Hum. (%)		Wind Speed (m/s)		Temp (C)		Rel. Hum. (%)	
Month	Norm	Dev	Norm	Dev	Norm	Dev	Norm	Dev	Norm	Dev	Norm	Dev
Jan	5.9	0.9	-7.4	0	57	4	5.6	0.3	-6.7	0	52	0
Feb	4.2	-2.2	-7.6	-3.2	57	7	3.9	-1.4	-6.4	-3.0	50	1
Mar	4.5	-1.0	-5.4	1.2	55	6	5.0	0.1	-3.8	0.9	46	2

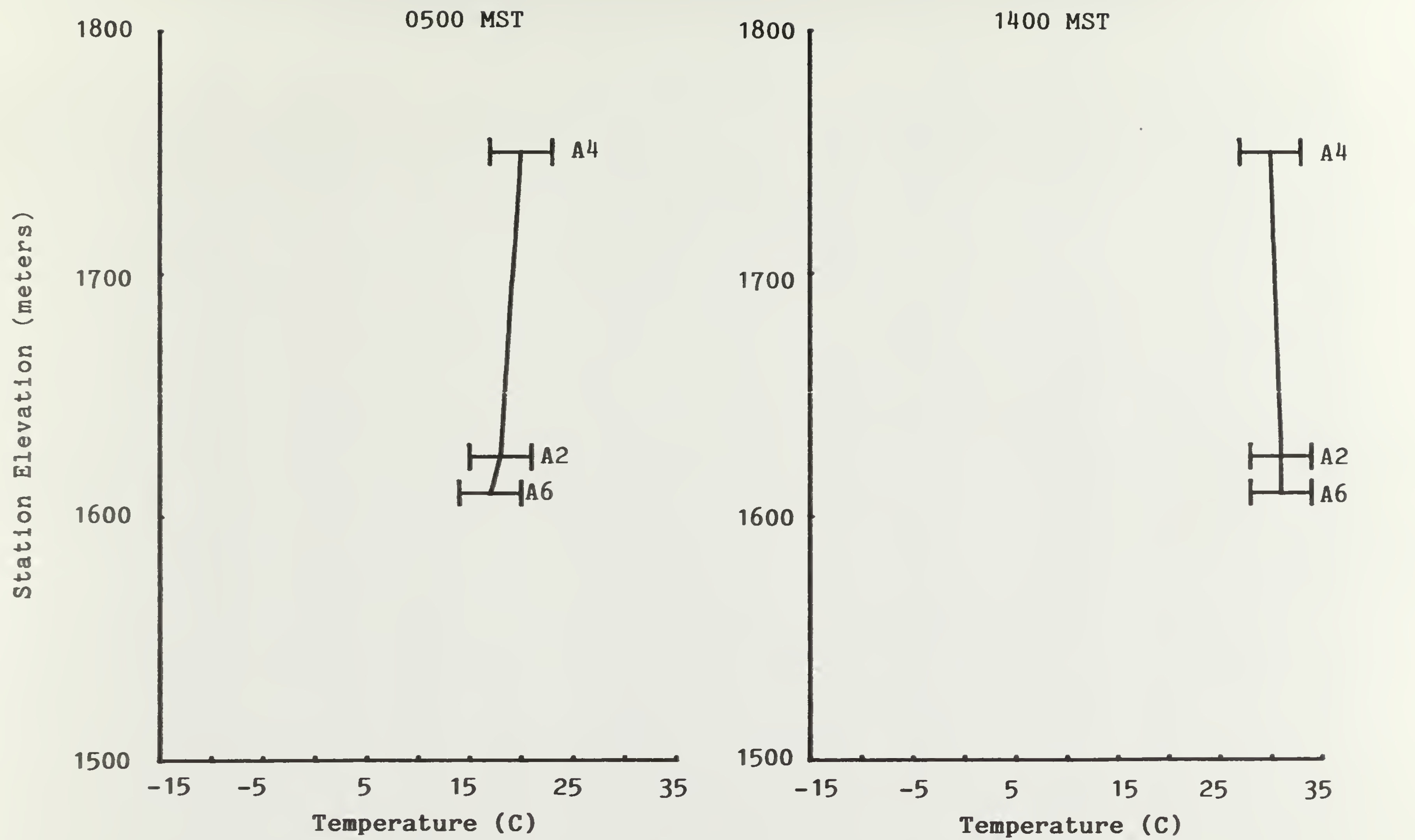


FIGURE III-7. AVERAGE JULY TEMPERATURE (0500 and 1400 MST) AND STANDARD DEVIATIONS AS A FUNCTION OF STATION ELEVATION. Multiply meters by 3.28 to get feet.

MST in July. The data is plotted against the height of the station to give a "sounding" of temperature. The average temperature at Station A-4 was comparable to that at Station A-2, temperatures at both stations were higher than the temperature at Station A-6 in the morning, and all three temperature readings were almost identical in the afternoon. This indicates the existence of surface-based inversions in the morning and near-neutral conditions in the afternoon above Station A-6.

As described in previous quarterly reports as well as in the First Year Environmental Baseline Report, a quantitative characterization of diffusivity on the tracts is possible by using the measurements of σ_v ($\sigma_\theta = \sigma_v/U$ and of σ_w made continuously at stations A-2, A-4 and A-6. Table III-4 shows the frequency distributions of the quantity $(\sigma_v \sigma_w)^{1/2}$, which is inversely proportional to X/Q at any given receptor location for the month of July at Station A-6. The data shown in the table indicates that diffusivity, in terms of $(\sigma_v \sigma_w)^{1/2}$, typically ranged from 0.2 to 0.8 m/s. Low values were generally observed at night and high values in the afternoon, as has generally been the case during the baseline program.

This approach to estimating diffusion does not require inference of low-altitude diffusion from temperature lapse rate data, a dubious process in the very rugged terrain of the area, but rather it presents quantitative measurements of actual diffusion. Using generally accepted boundary layer formulas, these values can often be extrapolated upward to allow estimation of conditions at levels above the 30-m tower tops.

3. AIR QUALITY

a. Gaseous Pollutants

Sulfur dioxide and H_2S are monitored at four stations on the tracts. In addition, CO, HC, NO_2, and O_3 are monitored at Station A-6. There are no state air quality standards for gaseous pollutants, but there are federal standards for all components except H_2S. For reference in the ensuing discussion, Table III-5 gives the Federal Ambient Air Quality Standards (AAQS) for the various gaseous pollutants monitored on the tracts. For H_2S, a reference for interpreting the data is the California 1-hour standard of 42 $\mu g/m^3$ (.03 ppm).

TABLE III-4

DIFFUSIVITY

Relative frequency distribution (%) of $\sigma_v \sigma_w$ (m/s) at Station A-6 in July, 1976. All measurements were made at 30 m above the surface. All hours of the day are included.

$\sqrt{\sigma_v \ \sigma_w}$ Range*	.00	.20	.40	.60	.80	1.00	1.20	>1.20	Total # of Obs.
% Frequency	0	21	38	21	15	3	0	0	742

* Each interval of $\sqrt{\sigma_v \ \sigma_w}$ spans 0.2 m/s and commences with the value shown.

TABLE III-5

FEDERAL AIR QUALITY STANDARDS FOR GASEOUS POLLUTANTS

Pollutant	Averaging Time	Primary Standards	Secondary Standards
Ozone (O_3)	1 hour	160 $\mu g/m^3$ (0.08 ppm)	Same as primary
Carbon Monoxide (CO)	8 hours	10 mg/m^3 (9 ppm)	Same as primary
	1 hour	40 mg/m^3 (35 ppm)	Same as primary
Sulfur Dioxide (SO_2)	Annual Average	80 $\mu g/m^3$ (0.03 ppm)	-
	24 hour	365 $\mu g/m^3$ (0.14 ppm)	-
	3 hour	-	1300 $\mu g/m^3$ (0.5 ppm)
Nitrogen Dioxide (NO_2)	Annual Average	100 $\mu g/m^3$ (0.05 ppm)	Same as primary
Hydrocarbons (corrected for methane - NMHC)	3 hour (6-9 a.m.)	160 $\mu g/m^3$ (0.24 ppm)	Same as primary

The air quality on the tracts has remained consistently good overall, as expected because of the remote location. Except for occasional occurrences of high non-methane hydrocarbon (NMHC) and H_2S readings, the air on the tracts this quarter was relatively clean with respect to gaseous pollutants. The only other pollutant present in measurable quantities was ozone. The ozone standard is 160 $\mu g/m^3$. Two hours came within 20 $\mu g/m^3$ of equalling the standard; the average concentration over this period was 80 $\mu g/m^3$. Otherwise, almost all instruments measuring gaseous pollutants were recording at their threshold limit most of the time.

A plot of dirunal variations of ozone at Station A-6 in July is shown on Figure III-8. The average diurnal trend consisted of low readings of about 50 g/m^3 (0.03 ppm) between 0400-0600 in the early morning hours and higher values of 100 $\mu g/m^3$ (0.05 ppm) between 1100-1800 in the afternoon. The air quality standards was not exceeded. Very little diurnal variation was observed for all other pollutants.

During July there were two days in which the 6-9 AM NMHC standard (160 $\mu g/m^3$) was exceeded. These two days showed levels of 1040 $\mu g/m^3$ and 930 $\mu g/m^3$. The average 6-9 AM values over the period was 100 $\mu g/m^3$. In the same month there were also 19 observations of H_2S readings higher than 42 $\mu g/m^3$ (California 1hr standard), all recorded at Station A-6. Investigations revealed that there were activities on and near the tracts in June and July that could have contributed to the high NMHC and H_2S values. Such activities included drilling core holes or wells in sections 7, 20, and 22 and venting gas wells in Asphalt Wash. All of these activities were upwind of Station A-6 when high H_2S readings were recorded.

Table III-6 shows the peak and second highest values as well as the percentage of observations exceeding standards for all gaseous pollutants observed in this quarter. The values are shown for the time averages for which air quality standards exist. The data presented is representative of the worst air quality situation on the tracts during this season. All of them, with the notable exception of ozone, H_2S, and NMHC values are near the detection thresholds of the instruments.

The air quality levels in this quarter compare well with those in the same period in 1975 except for H_2S and NMHC. The highest H_2S reading on the tracts in the summer of 1975 was 30 $\mu g/m^3$, and the highest 6-9 AM NMHC reading at Station A-6 was 390 $\mu g/m^3$. As noted before, the high readings observed this quarter may be attributable in part to local activities that did not take place last year.

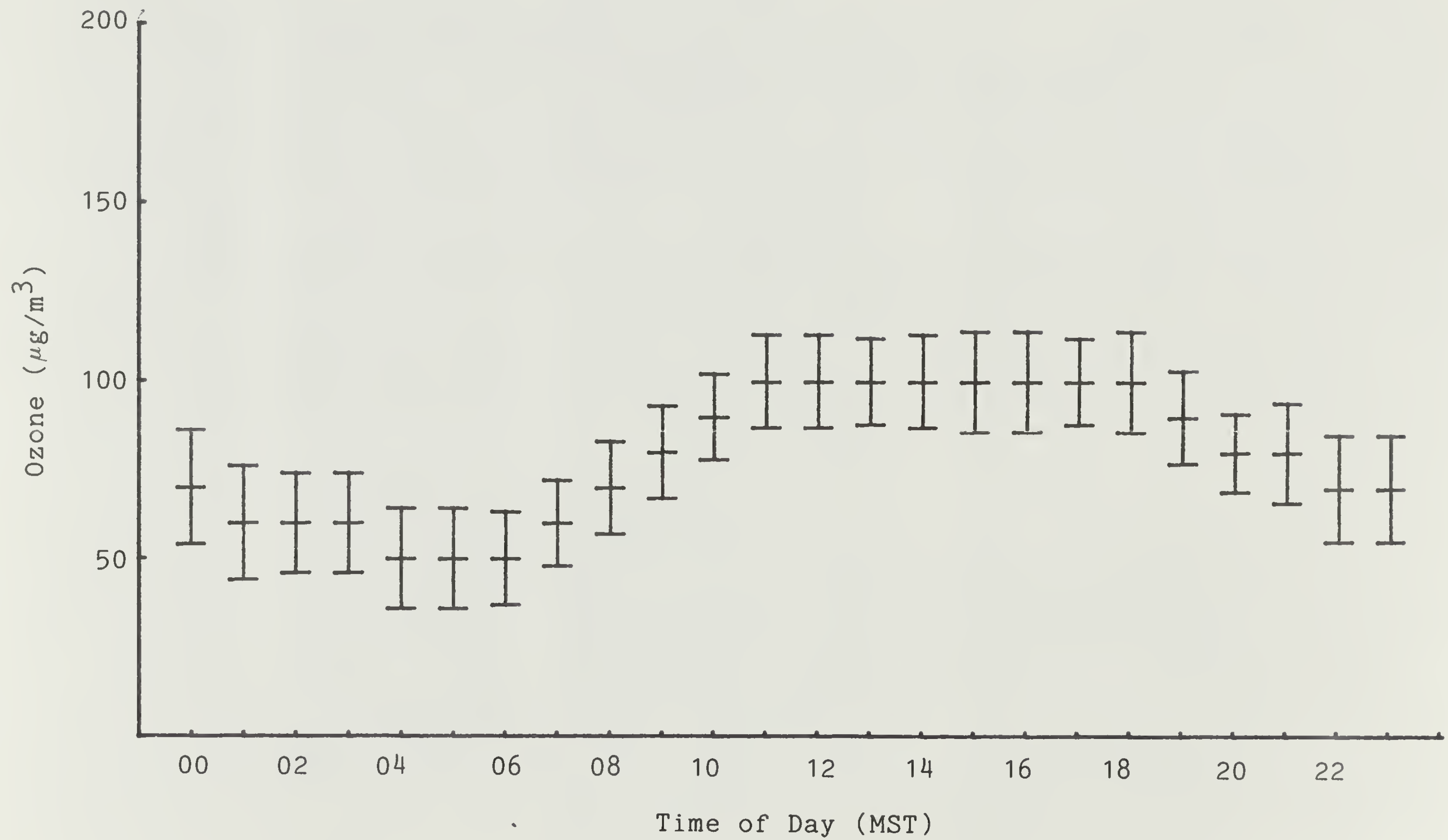


FIGURE III-8. OZONE CONCENTRATIONS. Diurnal variation in mean ozone concentrations with their standard deviations at Station A-6 during summer, based on data for the central month of the quarter (July).

TABLE III-6

PEAK GASEOUS POLLUTANT CONCENTRATIONS

The peak and second highest values as well as the percent of observations exceeding standards for all gaseous pollutants observed on the tracts in July 1976.

Pollutant	Average Time	Peak Conc.	Second Highest Conc.	Average	Standard	Percent Exceedance of Standard
O_3 ($\mu g/m^3$)	1 Hour	140	140	80	160	0
CO (mg/m^3)	8 Hours	.4	.4	0.2	10	0
	1 Hour	1.3	1.3	0.2	40	0
SO_2 ($\mu g/m^3$)	24 Hours	5	5	0	365	0
	3 Hours	10	10	0	1300	0
	1 Hour	20	15	0	-	-
H_2S ($\mu g/m^3$)	1 Hour	115	115	0	-	-
NO_2 ($\mu g/m^3$)	1 Hour	30	30	20	-	-
NMHC ($\mu g/m^3$)	3 Hour (6-9 A.M.)	1040	930	100	160	6

b. Particulates and Trace Metals

Particulate concentrations on the tracts are monitored by high volume samplers that sample over a period of 24 hours once every six days simultaneously at four air monitoring stations. The sizes of particulates collected by the samplers range from below 1 μm to somewhat above 25 μm.

Table III-7 gives the geometric mean, standard geometric deviation, and maximum and minimum of particulate concentrations in $\mu g/m^3$ at the four stations in the summer quarter. Data collected between June 1 and August 31, 1976, were used.

The geometric mean of particulate concentrations (which can be considered to correspond to the concentration medium) ranged from 15.3 $\mu g/m^3$ at Station A-7 to 34.8 $\mu g/m^3$ at Station A-6. There was noticeable spatial variation on the tracts, with Station A-6 monitoring the highest particulates. Concentrations at all sites were generally high on days with high winds.

None of the recorded values exceeded federal or state standards, which are shown on Table III-8. The most stringent short-term standard is the National Secondary Standard, which sets the upper limits at 150 $\mu g/m^3$ averaged over 24 hours; this is not to be exceeded more than once a year.

A set of size fractionated particulate samples was collected at Station A-2 by a Multistage Lundgren impactor every month for analysis of trace elements using ion-excited x-ray emission techniques at 50 microcoulombs. Analysis results of the last sample of last quarter and the first sample of this quarter are shown on Table III-9. Other samples collected during this quarter are being analyzed.

With the exception of normal soil constituents, most of the elements shown on Table III-9 were found at concentrations of less than or around 10 ng/m^3, with most of the mass generally found in the smaller size fractions. The elements found in larger quantities were Al, Si, S, K, Ca, and Fe. Concentrations of typical anthropogenic aerosols such as Cu, Zn and the automotive-derived aerosols of Br and Pb were very low, only a small percentage of typical urban values.

TABLE III-7

PARTICULATE CONCENTRATIONS

The geometric mean, standard geometric deviation, maximum and minimum of particulate concentrations ($\mu g/m^3$) at Stations A-3, A-4, A-6, and A-7 in the Summer quarter (1 June through 31 August 1976).

Station	Geometric Mean	Standard Geometric Deviation	Maximum	Minimum
A-3	21.4	1.4	35.7	12.2
A-4	19.2	2.4	60.5	5.3
A-6	34.8	1.4	63.9	18.7
A-7	15.3	2.1	37.3	3.3

TABLE III-8

AMBIENT AIR QUALITY STANDARD FOR PARTICULATE MATTER ($\mu g/m^3$)

Pollutant	Averaging Time	Utah Standards	National Standard	
			Primary	Secondary
Suspended Particulate Matter	Annual Geometric Mean	90	75	60
	24 Hour	200	260	150

TABLE III-9. TRACE ELEMENTS DETECTED AT STATION A-2 USING ION-EXCITED X-RAY EMISSIONS TECHNIQUE. Any elements not shown have not been detected.

Sampling Record	Sensitivity of Analysis	Size (μm) Range	Be	B	Na	Mg	Al	Si	S	Cl	K	Ca	Ti	V	Mn	Fe	Ni	Cu	Zn	As	Se	Br	Rb	Sr	Zr	Ba	Pt	Au	Hg	Pb
5/1-5/19	50 μC	3.6-20.0	-	A	B	-	B	D	A	*	B	C	A	*	*	C	*	A	B	-	-	*	A	-	A	*	A	-	-	A
		0.65-3.6	A	A	B	-	C	D	C	*	B	C	A	*	*	C	*	A	A	-	-	A	A	-	-	*	A	-	-	A
		0.10-0.65	-	-	B	-	B	D	D	*	B	C	A	*	A	C	A	A	A	-	A	A	A	B	-	*	-	A	-	B
6/3-6/18	50 μC	3.6-20.0	A	-	B	B	D	D	A	A	B	D	B	*	*	D	A	-	*	A	-	A	A	-	-	*	A	-	A	A
		0.65-3.6	A	-	B	B	C	D	B	A	C	D	A	*	*	C	*	-	*	A	-	A	A	-	-	*	A	-	A	A
		0.10-0.65	-	-	A	A	B	D	D	B	B	B	A	*	A	B	*	-	A	-	-	A	-	-	-	*	A	-	-	A

-	Element not found
*	Concentration < detection limit
A	10 ng/m^3 > concentration > 0 ng/m^3
B	50 ng/m^3 > concentration ≥ 10 ng/m^3
C	100 ng/m^3 > concentration ≥ 50 ng/m^3
D	500 ng/m^3 > concentration ≥ 100 ng/m^3
E	Concentration ≥ 500 ng/m^3

c. Visibility

The clarity of the atmosphere on the tracts is monitored by three methods: (1) continuous recording of light scattering coefficient with an integrating nephelometer at Station A-2; (2) photographic recording of visibility on color and monochromatic film from an observation point above Station A-9; and (3) visual observations while the photographic records are being made.

The integrating nephelometer recorded an average scattering coefficient of $0.05 \times 10^{-3} m^{-1}$ during this quarter, which corresponds to a local visual range (assuming a 2% contrast threshold for the eye) of 94 km (59 miles). The highest scattering recorded was $b_s = 0.07 \times 10^{-3} m^{-1}$, which corresponds to a local visual range of 67 km (40 mi) and which was observed between the hours 0800 and 1200 on July 18, 1976. The most clear hours had $b_s = 0.03 \times 10^{-3} m^{-1}$ (visual range 157 km, or 98 mi), which was mostly observed in the afternoon and evening hours. All observed values have corresponded to extremely clear, background-quality air. A very weak diurnal variation in scattering coefficient was observed, with the night and early morning hours showing slightly higher scattering (lower visibility) than did the afternoon and evening hours.

Photographic visibility measurements were made on June 3, July 3, and August 2. No significant obstructions to visibility were recorded. The photographically derived visibilities and those computed from the integrating nephelometer measurements correlate well, indicating as before that the Uinta Basin air mass is relatively homogeneous and that the localized nephelometer measurements are representative of a large area.

4. RADIATION

Thermo-luminescent dosimeters were used to continuously monitor ambient radiation at stations A-1 through A-12 during the quarter. The radioactivity dosages measured from May 21 through August 20 are tabulated on Table III-10. The readings, which ranged from 9 mR to 14 mR, are all in the normal ambient range and agree with the measurements of previous quarters.

Particulate matter collected by high-volume sampler filters at Station A-6 during May and July 1976 was analyzed for radiation by a gross alpha and beta measurement and an iso-

TABLE III-10

RADIATION LEVELS

Average radiation levels at all stations during 21 May - 20 August, as measured by three thermoluminescent dosimeters at each station.

A-1 - 9 mR	A-7 - 11 mR
A-2 - 14 mR	A-8 - 9 mR
A-3 - 9 mR	A-9 - 10 mR
A-4 - 13 mR	A-10 - 11 mR
A-5 - 9 mR	A-11 - 14 mR
A-6 - 12 mR	A-12 - 12 mR

topic gamma radiation scan. The results showed all radioactive isotope activities to be in the background range. Gross alpha and beta scans were all below 0.1pCi/m^3. Qualitative gamma scans revealed the presence of Be^7, Bi^{214} at less than 0.3, 0.1 and 0.2 pCi/m^3, respectively. Also present on the filter taken on May 6 was Mn^{54} at less than 0.1 pCi/m^3. Mn^{54} was first detected in April 1976, also at Station A-6. Other isotopes displayed significantly smaller activities.

C. WORK SCHEDULED

Routine monitoring and data processing of all air resources data will continue throughout the next quarter.

IV. BIOLOGICAL RESOURCES

A. WORK COMPLETED

1. VEGETATION

The vegetation on Tracts U-a and U-b was surveyed June 7 to June 17 using the same procedures followed in the three previous surveys (September 1974, June 1975, and September 1976). For greater statistical reliability the number of plots sampled was doubled, providing data from two hundred 4-m^2 plots per vegetation type as opposed to the 100 per type of previous surveys.

The data recorded from each 4-m^2 plot included plant species, plant height, species cover, and species density. Productivity of above-ground biomass of annual species was harvested from a small 0.25-m quadrat and separated according to two categories--forbs and grasses. Production data are reported in oven-dry weight.

Two additional evaluations in June 1975 included a reconnaissance survey of range condition by Dr. Don D. Dwyer, a range management expert (professor of Range Science and head of the Department of Range Science, Utah State University), and a measurement of stem growth of big sagebrush (*Artemisia tridentata*) in six typical sites on and adjacent to the tracts. The sagebrush was measured to evaluate this parameter as a possible index of year-to-year site productivity. A second series of measurements is planned for October for comparison with June measurements.

2. TERRESTRIAL VERTEBRATES

a. General

Tracts U-a and U-b are used for residence and visitation by 129 species of birds, 15 species of reptiles and amphibians, and 41 species of mammals. Two sampling efforts were completed during summer (June and August), the most active period on the tracts. A comparison of the 1975 and 1976 samples indicates the ways in which the vertebrates inhabiting the area respond to changing conditions.

b. Mule Deer

Three collared deer were monitored successfully during the quarter. Two were still being monitored at the end of August; the third radio had probably ceased functioning in mid-August. Of the two still functioning, one is transmitting a very poor signal and will probably quit in a short time, and the other is still transmitting a strong signal.

c. Canada Geese

The assessment of populations and production of Canada Geese for 1976 is now essentially complete.

d. Cottontail Rabbits

As an indication of relative cottontail rabbit populations on the project area, daylight rabbit counts were made concurrently with mourning dove coo-call-count routes. Routes were begun one-half hour before sunrise and extended for 32 km (20 mi).

e. Mourning Doves

In early June a mourning dove coo-call route was established through the project area and run at intervals from June through August. The methodology used in coo-call routes is explained in the First Year Environmental Baseline Report.

f. Pellet Group Transects

A series of pellet-group transects was established on the project area in late May and early June 1976 to indicate areas and intensities of use by mule deer. Two types of transects--swept and random--were used. Swept-pellet transects were constructed by driving stakes at 14-m (45-ft) intervals through the area to be surveyed. From each stake a circle with a 171-cm (67½-in.) radius was swept of all old pellets to create a swept area of 40 m^2 (440 ft^2). Transects were laid out in series of 25 or 50 plots. The plots are relatively permanent and allow comparison of data from year to year in the same area. A total of 125 plots were placed in each of the four vegetative types on the project area.

Random transects were constructed by traversing an area on a straight line course, stopping every 15 paces, and counting pellet groups within a 171-cm (57½-in.) radius of the right foot of the observer. Only pellet groups of the immediately preceding winter were counted. No sweeping was done on these transects. A series of 1200 plots in 12 transects of 100 plots each was completed. Three hundred plots were read in each vegetative type.

g. Amphibians and Reptiles

Field work in the amphibian and reptile program was completed in August 1976. Amphibians were collected in riparian areas along the White River in June, July, and August. Animals were captured by hand or hand net, identified, and released.

Lizards were captured in June during daily walks through a 1-hectare (ha) plot in each vegetation type. The study plots were situated near or on vegetation sampling sites. The lizards were captured by a slip-knotted noose on the end of a pole and were marked with a spot of red nail polish dorsally between the hind legs for subsequent identification. The plots were walked for five consecutive days in June, July, and August, and all marked and unmarked lizards were recorded. The time of day of walk-throughs were varied for random sampling of species known to have different activity periods.

Snakes were observed during the amphibian and lizard studies. In addition, night "road runs" were conducted because snakes are easily seen on roads, and other field biologists working on the tracts were field trained to identify snake species. All observations will be included in the Final Environmental Baseline Report. All nomenclature follows Stebbins (1966).

3. TERRESTRIAL INVERTEBRATES

Work completed during the quarter included determining various groups of insects, sending other groups to specialists for determination, receiving some previously sent, and incorporating determined material into the validation collection.

Three field trips to the sites were necessary to collect routine quantitative samples and for additional observations. The following groups of arthropods have now been determined:

(1) Diptera: all families except Empidae and Pipunculidae (some completed after the close of the quarter but available at this writing).

(2) Hymenoptera: all families except Encyrtidae, Eulophidae, Eupelimidae, several small chalcidoid families, all proctotrupoid families, and Ichneumonidae. (Aculeate wasps and Apoidea (bees) completed after the close of the quarter but available at this writing.

(3) Coleoptera: completed families include Chrysomelidae, Coccinellidae, Scarabaeidae, Cerambycidae, Elateridae, Buprestidae, Malachidae, Meloidae, Hydrophilidae, Dytiscidae, Cicindillidae, and Tenebrionidae.

(4) Hempitera (including Homoptera): out for determination.

(5) Lepidoptera: all out for determination except butterflies (completed) and Microlepidoptera (sent out and returned, but determined only to family in most cases).

(5) Araneida (spiders): partially determined; one shipment still out for determination.

(6) Miscellaneous orders: being determined at Logan.

4. AQUATIC BIOLOGY

On-site sampling of algae, invertebrates, and fishes was conducted from August 9 through August 18, 1976. Spring runoff abated well before the sampling period began, and discharge in the White River and Evacuation Creek was at the normal summer low. In both streams, local thunderstorms have contributed considerable sediment, and transparency has been reduced to less than 2 cm. During the low-flow periods, many of the meanders dry up, particularly those at stations F-1 and F-5 (see diagrams in <u>Quarterly Report No. 4</u>).

Several physical changes in the streambed of the White River were noted: Below the Ignacio Bridge the area covered with sand in April was apparently scoured out by the spring flood and is now composed of boulders and rubble. A backwater approximately 100 m downstream of the gage at Station F-4 that has persisted throughout the study was silted in by the spring flood, and the area is now dry land.

During the August study period, discharge rates varied from between 8500 l/s and 9910 l/s (300 cfs and 350 cfs). Technicians reported that Evacuation Creek was running and muddy

August 9. The creek was not examined until August 15, when it was dry except in the area where the streambed descends through the bird's nest aquifer. Water appeared in the streambed approximately 500 m above Station F-6 and flowed from there to 300 m above the confluence of the White River, where the water again seeped into the alluvial aquifer.

5. MICROBIOLOGY

This report includes the results of data analysis during the reporting period and analysis of 1976 data not previously submitted. In addition, some parameters affecting microbial status in the soil were evaluated to assess trends in the data collected during the 1975 sampling period.

The metabolic activity and microbial plate counts recorded in this quarter indicate a somewhat higher level of activity than the level reported in the same period in 1975 and a general slowdown of activity with the approach of winter. Moisture appeared to be the factor most responsible for the higher values, although an increased level of organic substrates may have been significant also.

In all parameters data from the two years of monitoring are being analyzed with regard to significant trends in activities and the environmental factors affecting them. Precipitation, temperature, and snowmelt data are also being analyzed for use in evaluating the environment and the seasonal changes at each site. These data will be used to define the causes and effects of biological activity at each of the sites.

B. DATA SUMMARY

1. VEGETATION

a. Vegetation Parameters

Species, height, cover, and density recorded in June 1976 differed markedly in many aspects from that observed in June 1975 because growing conditions during late winter and early spring 1976 were less favorable than in 1975. Fewer annual species were present in 1976, and they were shorter and less dense. Plant heights were shorter for annual species, but height was not noticeably different for perennial shrubs. The survey team observed substantial

differences from the previous year in each vegetation type. The parameters of the four vegetation types were as follows:

Sagebrush/Greasewood (Vegetation Type 1)

In general, more species of sagebrush/greasewood were sampled than previously to approach or exceed the sample size required to estimate within 25% of the mean at a 90% confidence level (Table IV-1). Eleven important perennial species were adequately sampled: Artemisia nova, Artemisia tridentata, Astragalus divaricata, Atriplex confertifolia, Chrysothamnus visicidiflorus, Grayia spinosa, Oryzopsis hymenoides, Sarcobatus vermiculatus, Sitanion hystrix, Sphaeralcea coccinea, and Stipa comata. Plant height, a less variable parameter, was sampled in 25 species in the 100 plots examined.

Juniper (Vegetation Type 2)

In Juniper a large amount of bare ground was recorded, and significant numbers of understory species were found only in the interspaces (Table IV-2). Generally, Bromus tectorum was not found in juniper. Eight species, including juniper, were sampled adequately: Chrysothamnus viscidiflorus, Cryptantha spp, Eirogonum spp, Euphorbia fendleri, Hedysarum boreal, Hillaria jamesii, Juniperus osteosperma, and Petradoria pumila. A number of shrubs, such as sagebrush and Gutierrezia sarothrae, approached sampling adequacy.

Shadscale (Vegetation Type 3)

In shadscale, which should be considered shadscale/sagebrush, there were fewer species and plants in 1975 than in 1976. Species sampled adequately included Artemisia spinescens, Artemisia tridentata, and Atriplex confertifolia (Table IV-3). Several other shrub species approached sampling adequacy but were not sufficiently dense to be included in the plots analyzed. Again, a substantial reduction in the number of annual grasses and forbs was noted; for example, Bromus tectorum was very patchy and did not form extensive stands as in 1975.

TABLE IV-1

SAGEBRUSH/GREASEWOOD VEGETATION CHARACTERISTICS. Data are for the number of observations, mean, 90% confidence interval about the mean and sample size required to estimate within 25% of the mean with a 90% statistical confidence.

VEGETATION TYPE 1

Species	Height (cm)				Cover ($cm^2/4m^2$)				Density (individual/$4m^2$)			
	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE
AGRINE	-	-	- -	-	1	14.0	- -	-	1	1.0	- -	-
ALLIUM	2	12.5	19.8 5.2	3.5	2	20.0	34.6 5.4	5.4	2	3.0	3.0 3.0	-
ARTEMI	-	-	- -	-	1	11.0	- -	-	1	4.0	- -	-
ARTFRI	3	12.3	23.4 1.3	18.9	3	156.7	409.9 -96.6	61.3	3	2.7	6.6 -1.3	50.7
ARTNOV	11	11.8	13.6 10.0	3.3	11	497.7	620.7 374.8	9.0	11	3.6	5.0 2.1	25.0
ARTNOVSD	2	3.5	10.8 -3.8	44.2	6	155.5	331.4 -20.4	88.0	6	4.1	3.9 1.4	30.3
ARTSPI	8	11.9	14.4 9.3	4.5	10	403.0	610.6 195.4	35.0	10	5.0	9.2 .8	93.9
ARTTRI	119	36.7	38.7 34.8	5.5	123	2088.2	2335.3 1841.1	27.6	123	3.3	3.6 3.0	19.6
ARTTRISD	-	-	- -	-	7	78.4	180.9 -24.1	144.2	7	1.7	2.4 1.0	13.3
ASTCHI	6	15.5	22.7 8.3	15.0	6	30.3	67.6 -6.9	103.7	6	1.0	1.0 1.0	-
ASTDIV	3	31.0	53.9 8.2	12.7	3	21.7	35.8 7.5	10.0	3	1.3	2.1 0.6	8.1
ASTRAG	20	9.5	14.3 4.7	73.5	20	75.1	126.4 23.8	135.6	20	2.2	2.7 1.7	17.5
ATRCAN	1	41.0	- -	-	1	250.0	- -	-	1	1.0	- -	-
ATRCON	42	19.8	21.9 17.8	7.4	44	357.1	427.6 286.5	27.5	44	2.0	2.4 1.5	37.9
ATRCONSD	-	-	-- -	-	5	44.0	72.7 15.3	22.7	5	1.6	2.1 1.1	5.1
ATRIPL	1	11.0	- -	-	1	15.0	- -	-	1	3.0	- -	-
BARGRO	-	-	- -	-	199	31388.2	32247.1 30529.3	2.4	199	1.0	1.0 1.0	-

TABLE IV-1 (Cont.)

VEGETATION TYPE 1

Species	Height (cm)				Cover ($cm^2/4m^2$)				Density (individual/$4m^2$)			
	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE
BORAGI	4	2.5	3.6 1.4	6.9	4	12.5	19.3 5.7	11.4	4	5.8	11.8 -0.3	42.2
BROTEC	134	14.2	14.7 13.7	2.7	134	1059.9	1478.8 641.1	334.8	134	688.8	830.9 546.6	91.3
CASSCA	1	25.0	- -	-	1	15.0	- -	-	1	1.0	- -	-
CERLAN	5	20.8	28.5 13.1	7.4	5	267.0	500.2 33.8	40.6	5	3.0	5.6 0.5	38.5
CHADOU	8	6.4	9.9 2.8	31.0	8	18.0	31.5 4.5	56.3	8	4.3	9.5 -1.0	155.3
CHRGRE	5	28.0	38.4 17.6	7.3	6	1270.0	2290.9 249.1	44.5	6	2.8	4.5 1.1	24.6
CHRNAU	9	44.1	56.4 31.9	8.9	12	636.3	1021.1 251.4	59.8	12	1.2	1.4 1.0	4.8
CHRVIS	34	34.3	37.3 31.3	4.2	38	893.8	1112.9 674.7	36.5	38	2.7	3.3 2.2	24.9
CHRVISSD	1	2.0	- -	-	3	13.3	27.2 -0.5	25.4	3	1.7	2.5 0.9	5.2
CLELUT	9	16.1	19.1 13.1	3.9	9	9.7	17.0 2.3	67.3	9	1.4	1.9 1.0	10.9
COMPOS	1	15.0	- -	-	1	4.0	- -	-	1	1.0	- -	-
CRYPTA	20	6.8	7.9 5.6	8.5	20	267.7	449.9 85.5	134.8	20	84.6	178.1 -8.9	355.2
DISSTR	1	7.0	- -	-	1	40.0	- -	-	1	5.0	- -	-
ERIOGO	12	5.9	6.6 2.9	2.4	12	45.5	59.8 5.2	16.1	12	4.4	5.7 3.2	12.7
EUPFEN	14	3.0	3.6 2.4	8.1	14	197.9	296.1 99.6	48.2	14	2.6	3.5 1.7	23.9
FRAACA	16	7.2	8.7 5.7	10.1	16	164.7	266.4 63.0	86.6	16	11.9	20.6 3.2	121.2
GRASPI	45	37.4	40.0 34.9	3.2	51	1645.6	2028.2 1262.9	44.1	51	139.0	364.8 -86.8	2152.7

TABLE IV-1 (Cont.)

VEGETATION TYPE 1

Species	Height (cm)				Cover ($cm^2/4m^2$)				Density (individual/$4m^2$)			
	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE
GRASPISD	-	-	- -	-	1	50.0	-	-	1	1.0	- -	-
GUTSAR	23	15.5	18.8 12.2	15.7	25	141.7	193.1 90.4	48.7	25	3.4	4.6 2.2	48.4
HALGLO	1	6.0	- -	-	1	150.0	- -	-	1	50.0	- -	-
HILJAM	35	13.7	16.2 11.2	18.6	35	303.4	427.5 179.4	93.6	35	17.4	24.4 10.5	88.2
KOCSCO	3	10.7	16.8 4.5	7.7	3	1198.3	3906.7 -1510.1	119.8	3	68.3	195.3 -58.6	80.9
LEPFRE	25	33.5	37.6 29.4	5.6	25	42.4	60.7 24.0	69.7	25	1.6	2.0 1.3	18.6
LEPMON	6	11.0	20.9 1.1	55.5	6	14.8	29.1 0.6	63.5	6	5.0	9.8 0.2	62.3
LEPWAT	1	11.0	- -	-	1	60.0	- -	-	1	1.0	- -	-
LITTER	-	-	- -	-	199	4448.7	5150.6 3746.7	79.3	199	1.0	1.0 1.0	-
LUPINU	1	10.0	- -	-	1	11.0	- -	-	1	1.0	- -	-
MELOFF	1	5.0	- -	-	1	450.0	- -	-	1	28.0	- -	-
MENALB	15	13.8	16.0 11.6	5.5	15	112.9	187.8 38.1	92.9	15	55.5	86.8 24.3	67.0
OPURHO	15	13.2	16.0 10.4	9.6	15	195.9	272.3 119.4	32.2	15	2.1	3.2 1.1	50.1
ORYHYM	92	29.7	31.2 28.2	3.9	92	360.6	410.4 310.8	28.1	92	7.7	9.1 6.2	52.2
PENSTE	2	4.0	4.0 4.0	-	2	28.0	63.0 -7.0	15.9	2	1.0	1.0 1.0	-
PHLLON	4	4.8	5.8 3.7	1.8	5	53.0	69.1 36.9	4.9	5	20.2	31.1 9.3	15.4
POASAN	3	17.3	38.2 -3.6	34.0	3	41.7	99.4 -16.1	45.1	3	1.0	1.0 1.0	-

TABLE IV-1 (Cont.)

VEGETATION TYPE 1

Species	Height (cm)				Cover ($cm^2/4m^2$)				Density (individual/$4m^2$)			
	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE
SALKAL	42	7.1	7.9 / 6.3	8.2	42	1834.8	2499.9 / 1169.7	88.3	42	910.3	1215.3 / 605.4	75.4
SARVER	53	52.9	57.6 / 48.3	6.6	66	1237.4	1513.2 / 961.5	52.5	66	1.7	2.0 / 1.5	21.7
SARVERSD	-	-	- / -	-	12	67.5	93.4 / 41.6	24.1	12	1.8	2.5 / 1.2	18.3
SISALT	2	17.5	54.0 / -19.0	44.2	2	102.5	387.2 / -182.2	78.3	2	6.5	16.7 / -3.7	25.1
SISLIN	28	40.0	43.3 / 36.7	2.9	28	25.1	34.4 / 15.8	57.5	29	3.7	4.9 / 2.5	42.2
SITHYS	51	26.6	28.5 / 24.7	4.0	51	46.4	54.9 / 37.8	27.8	51	1.9	2.4 / 1.5	52.6
SPHCOC	10	10.8	12.9 / 8.7	5.2	10	50.8	64.9 / 36.7	10.2	10	3.1	5.1 / 1.1	54.5
SPHSUB	10	6.9	8.3 / 5.5	5.5	10	23.5	34.9 / 12.1	31.0	10	1.0	1.0 / 1.0	-
STEPAU	2	18.0	53.0 / -17.0	38.5	2	82.5	133.6 / 31.4	3.9	2	4.5	6.0 / 3.0	1.1
STICOM	39	30.0	32.5 / 27.4	4.5	39	500.1	612.0 / 388.2	31.2	39	12.4	15.8 / 9.0	46.8
SUANIG	12	26.7	34.3 / 19.1	13.2	12	175.9	252.9 / 99.0	31.3	12	3.1	4.8 / 1.3	53.4
TETGLA	3	40.7	42.2 / 39.1	-	3	466.7	1108.7 / -175.3	44.4	3	2.7	6.6 / -1.3	50.7
TETSPI	15	42.3	47.8 / 36.7	3.7	15	622.7	965.0 / 380.4	32.0	15	1.5	1.9 / 1.2	12.8

TABLE IV-2

JUNIPER VEGETATION TYPE CHARACTERISTICS. Data are for the number of observations, mean 90% confidence interval about the mean and sample size required to estimate within 25% of the mean with a 90% statistical confidence.

VEGETATION TYPE 2

Species	Height (cm)				Cover ($cm^2/4m^2$)				Density (individual/$4m^2$)			
	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE
AGRDES	1	30.0	- -	-	1	700.0	- -	-	1	30.0	- -	-
AGRINE	7	21.9	28.0 15.7	6.7	7	257.1	365.4 148.9	15.0	7	5.1	7.7 2.6	21.0
ARENAR	23	4.1	5.1 3.2	17.1	23	21.0	31.1 10.8	79.7	23	2.1	2.7 1.5	29.7
ARTNOV	85	15.2	16.4 14.1	7.8	85	975.1	1311.6 638.6	162.0	85	4.3	4.8 3.8	19.1
ARTNOVSD	28	4.8	5.6 3.9	13.1	66	105.8	137.7 73.9	96.1	66	3.8	4.5 3.4	40.8
ARTTRI	10	32.0	39.1 24.9	6.5	10	769.5	1547.0 -8.0	134.6	10	2.8	4.4 1.6	40.2
ARTTRISD	-	-	- -	-	1	30.0	- -	-	1	2.0	- -	-
ASTRAG	13	7.6	10.5 4.7	26.4	13	27.2	37.6 16.8	26.2	13	1.1	1.2 0.9	2.9
ATRCON	30	18.9	21.7 16.0	10.2	32	194.2	250.7 137.8	43.3	32	1.3	1.5 1.1	12.3
ATRCONSD	19	5.7	6.4 5.0	4.2	39	46.2	57.3 35.2	35.6	39	1.5	1.7 1.3	11.6
BARGRO	-	-	- -	-	198	34543.0	35449.6 33636.5	2.2	198	1.0	1.0 1.0	-
BORAGI	1	5.0	- -	-	1	18.0	- -	-	1	10.0	- -	-
BROTEC	30	7.3	8.2 6.4	6.9	30	5.5	9.7 1.3	266.1	30	10.7	17.9 3.6	201.7
CASSCA	2	16.0	27.7 4.3	5.4	2	19.0	51.1 -13.1	29.0	2	1.5	3.0 0.0	9.6
CERLAN	1	12.0	- -	-	1	100.0	- -	-	1	1.0	- -	-
CHRGRE	5	34.0	41.4 26.6	2.5	5	450.0	1031.4 -131.4	89.0	5	2.4	4.3 0.5	32.3
CHRNAU	4	37.8	36.9 18.6	4.1	4	462.5	850.2 74.8	26.8	4	1.0	1.0 1.0	-

TABLE IV-2 (Cont.)

VEGETATION TYPE 2

Species	Height (cm)				Cover ($cm^2/4m^2$)				Density (individual/$4m^2$)			
	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE
CHRVIS	65	19.2	21.3 17.1	12.8	65	211.7	383.8 139.5	12.8	65	5.3	6.5 4.1	53.8
CHRVISSD	25	6.0	6.6 5.4	3.3	26	48.3	76.7 19.9	134.0	26	3.9	5.3 2.5	48.6
COMPOS	6	7.5	11.4 3.7	18.1	6	36.9	81.4 -7.7	100.5	6	1.5	2.2 0.8	13.5
CRYPTA	114	8.3	9.1 7.4	19.2	114	60.0	68.7 51.3	38.6	114	2.5	2.8 2.2	23.7
DISSTR	19	9.2	10.5 7.9	5.6	19	217.9	314.6 121.2	54.1	19	12.6	16.3 9.0	23.4
ECHINO	2	1.5	3.0 0.0	9.6	2	17.5	39.4 -4.4	15.9	2	1.0	1.0 1.0	-
EPHNEV	2	26.5	74.7 -21.7	33.6	2	80.0	109.2 50.8	1.4	2	1.0	1.0 1.0	-
ERICER	2	1.5	3.0 0.0	9.6	2	1.5	3.0 0.0	9.6	2	1.5	3.0 0.0	9.6
ERIGER	4	5.8	9.3 2.2	14.3	4	33.8	66.7 0.8	36.3	4	2.3	4.9 -0.4	53.4
ERIOGO	89	5.4	5.8 4.9	10.5	90	35.4	40.4 30.5	28.4	90	2.7	3.0 2.4	17.3
ERIOVA	17	4.2	5.5 3.0	21.6	17	44.9	57.4 32.4	18.8	17	2.4	3.7 1.1	73.5
EUPFEN	83	2.4	2.7 2.1	15.4	83	39.0	46.4 31.7	47.2	83	2.5	3.0 2.0	52.8
FORMEI	1	15.0	- -	-	1	150.0	- -	-	1	1.0	- -	-
GILCAE	11	3.4	5.0 1.7	36.2	11	10.2	17.9 2.5	85.0	11	3.3	5.1 1.5	45.3
GILCON	4	1.5	2.6 0.4	19.2	4	18.3	28.1 8.4	11.1	4	1.0	1.0 1.0	-
GILIA	1	7.0	- -	-	1	10.0	- -	-	1	1.0	- -	-
GUTSAR	36	14.5	16.1 12.8	7.7	36	54.3	68.6 40.0	39.6	36	2.8	3.4 2.3	21.9

TABLE IV-2 (Cont.)

VEGETATION TYPE 2

Species	Height (cm)				Cover ($cm^2/4m^2$)				Density ($individual/4m^2$)			
	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE
HALGLO	1	1.0	- -	-	1	1.0	- -	-	1	2.0	- -	-
HEDBOR	47	20.7	22.9 18.5	8.7	48	159.7	198.6 120.7	45.7	48	1.7	2.0 1.4	20.8
HILJAM	36	8.2	9.1 7.2	7.7	36	214.3	253.6 175.0	19.4	36	11.4	13.7 9.1	23.6
JUNOST	59	213.1	239.2 186.9	14.2	98	15275.9	17424.4 13127.4	31.0	98	1.0	1.1 1.0	1.2
JUNOSTSD	-	-	- -	-	5	297.0	853.4 -259.4	187.1	5	1.2	1.6 0.8	6.0
KOCAME	1	14.0	- -	-	1	50.0	- -	-	1	6.0	- -	-
LEGUMI	2	30.0	59.2 0.8	9.6	2	17.5	39.4 -4.4	15.9	2	2.0	4.9 -0.9	21.6
LEPFRE	53	21.1	24.1 18.0	18.0	53	26.1	33.4 18.7	68.1	53	3.3	4.0 2.6	41.2
LEPPER	3	6.3	13.0 -0.4	26.3	3	151.7	443.9 -140.5	87.0	3	6.3	17.7 -5.1	75.9
LEPPUN	13	6.5	9.1 4.0	27.6	13	163.4	260.3 66.5	63.1	13	3.3	4.8 1.8	35.2
LEPWAT	2	2.0	2.0 2.0	-	2	13.5	23.7 3.3	5.8	2	1.5	3.0 -	9.6
LITTER	-	-	- -	-	197	3279.3	4099.1 2459.4	197.0	197	1.0	1.0 1.0	-
MACGRI	9	14.9	19.5 10.3	11.1	9	40.9	72.0 9.8	67.1	9	1.2	1.6 0.8	12.9
MELOFF	1	20.0	- -	-	1	60.0	- -	-	1	2.0	- -	-
OENCAE	12	2.3	3.2 1.3	28.2	12	18.3	23.5 13.0	13.4	12	1.5	1.9 1.1	12.2
OPURHO	5	7.4	10.6 4.2	10.1	5	126.0	221.1 30.9	30.3	5	1.6	2.4 0.8	13.5
ORYHYM	97	18.3	19.6 16.9	8.8	98	303.3	532.4 74.3	894.1	98	4.3	5.2 3.4	70.8

TABLE IV-2 (Cont.)

VEGETATION TYPE 2

Species	Height (cm)				Cover ($cm^2/4m^2$)				Density (individual/$4m^2$)			
	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE
PENSTE	1	3.0	- -	-	1	20.0	- -	-	1	1.0	- -	-
PETPUM	41	10.9	12.2 9.7	8.4	41	216.2	265.3 167.1	33.9	41	4.2	5.1 3.4	29.3
PHLOX	2	11.0	25.6 -3.6	17.9	2	22.0	74.6 -30.6	58.0	2	2.5	6.9 -1.9	31.2
PHYNEW	33	3.1	3.4 2.7	5.8	33	19.4	26.3 12.5	66.5	33	1.7	2.0 1.4	15.3
PINEDU	3	62.7	198.4 -73.0	110.0	3	3337.7	11175.9 -4500.6	129.4	3	1.7	3.2 0.1	20.8
POASAN	25	7.7	8.9 6.5	9.0	25	50.0	68.0 31.9	48.6	25	3.4	4.4 2.5	29.0
SARVER	2	64.0	198.3 -70.3	44.7	3	210.0	492.7 -72.7	42.5	3	1.0	1.0 1.0	-
SISALT	1	25.0	- -	-	1	5.0	- -	-	1	1.0	- -	-
SISLIN	15	20.5	25.0 16.0	10.3	15	19.3	31.2 7.5	79.5	15	8.7	14.5 2.9	94.3
SITHYS	19	18.5	21.1 15.9	5.5	19	69.0	123.3 14.7	170.3	19	5.8	8.5 3.2	57.2
STICOM	10	23.2	30.5 15.9	13.1	10	250.9	509.4 -7.6	140.0	10	8.3	14.3 2.3	68.7
STRCOR	32	7.3	10.0 4.7	67.5	32	18.6	25.5 11.8	69.2	32	1.8	2.3 1.3	37.6
THEFLE	1	13.0	- -	-	1	18.0	- -	-	1	1.0	- -	-

TABLE IV-3

SHADSCALE VEGETATION CHARACTERISTICS. Data are for the number of observations, mean, 90% confidence interval about the mean and sample size required to estimate within 25% of the mean with a 90% statistical confidence.

VEGETATION TYPE 3

Species	Height (cm)				Cover ($cm^2/4m^2$)				Density ($individual/4m^2$)			
	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE
AGRINE	1	30.0	- -	-	1	100.0	- -	-	1	4.0	- -	-
ARTFRI	4	13.0	21.6 4.4	16.6	4	82.8	141.9 23.6	19.5	4	2.5	4.4 0.7	20.8
ARTNOV	22	19.9	21.6 18.3	2.2	22	812.8	1068.3 557.2	31.9	22	2.2	2.6 1.7	13.5
ARTNOVSD	-	-	- -	-	3	21.3	55.2 -12.5	59.0	3	3.0	5.7 0.3	19.2
ARTSPI	22	11.1	13.3 8.8	13.2	24	196.8	242.3 151.3	19.0	24	2.7	3.5 2.0	26.9
ARTTRI	89	36.0	38.0 34.0	4.4	92	1368.9	1527.7 1210.1	19.8	92	2.7	3.0 2.4	20.3
ARTTRISD	2	2.5	6.9 -1.8	31.2	35	59.4	102.8 16.0	298.7	35	5.9	8.1 3.7	77.4
ASTCHI	10	13.1	16.9 9.3	11.0	10	9.4	13.0 5.8	19.1	10	1.3	1.7 0.9	11.7
ASTMEG	1	4.0	- -	-	1	50.0	- -	-	1	1.0	- -	-
ASTRAG	7	7.1	10.5 3.8	18.8	8	26.0	46.2 5.8	60.6	8	1.8	2.3 1.2	11.1
ATRCON	163	20.7	21.8 19.7	6.6	165	559.9	651.0 468.8	69.9	165	3.2	3.5 3.0	18.0
ATRCONSD	7	7.0	7.7 6.3	0.9	80	34.5	46.5 22.5	155.7	80	2.5	2.9 2.1	32.5
ATRIPL	-	-	- -	-	2	35.0	78.8 -8.8	15.9	2	35.0	78.8 -8.8	15.9
BARGRO	-	-	- -	-	199	37633.3	37785.8 37480.8	0.1	199	1.0	1.0 1.0	-
BROTEC	88	10.2	10.7 9.7	2.8	93	229.3	326.6 132.0	268.1	93	491.1	693.2 289.0	252.0
CERLAN	1	18.0	- -	-	1	50.0	- -	-	1	2.0	- -	-

TABLE IV-3 (Cont.)

VEGETATION TYPE 3

Species	Height (cm)				Cover ($cm^2/4m^2$)				Density (individual/$4m^2$)			
	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE
CERLANSD	2	5.5	7.0 4.0	0.7	3	12.0	27.7 -3.7	40.0	3	1.0	1.0 1.0	-
CHADOU	11	7.0	8.4 5.6	5.8	12	59.3	133.8 -15.3	258.8	12	9.5	16.2 2.8	81.8
CHRGRE	2	14.5	18.9 10.1	1.0	2	275.0	786.0 -236.0	35.1	2	3.0	5.9 0.1	9.6
CHRGRESD	-	-	- -	-	1	5.0	- -	-	1	1.0	- -	-
CHRNAU	3	35.0	43.5 26.5	1.4	4	312.5	734.7 -109.7	69.5	4	1.0	1.0 1.0	-
CHRNAUSD	-	-	- -	-	2	8.5	18.7 -1.7	14.7	2	1.5	3.0 -	9.6
CHRVIS	21	32.2	37.2 27.3	7.2	21	771.2	1020.7 521.6	32.1	21	2.0	2.5 1.4	22.1
CHRVISSD	2	4.5	8.9 0.1	9.6	6	18.3	32.6 4.1	41.7	6	1.8	2.6 1.1	12.4
CRYGRM	-	-	- -	-	59	140.4	200.5 80.3	172.9	59	1.6	1.9 1.3	24.8
CRYPTA	3	12.3	25.7 -1.1	27.7	4	10.0	17.4 2.6	20.8	4	1.0	1.0 1.0	-
ERIMIC	2	25.0	39.6 10.4	3.5	2	275.0	932.0 -382.0	58.0	2	1.0	1.0 1.0	-
ERIOGO	34	13.3	15.8 10.7	20.5	38	302.2	387.8 216.7	48.7	38	3.6	4.4 2.8	27.1
ERIOVA	1	10.0	- -	-	1	75.0	- -	-	1	3.0	- -	-
EUPFEN	14	6.1	10.8 1.5	109.9	16	59.1	81.5 36.6	32.7	16	3.2	4.7 1.7	51.8
GILCON	1	22.0	- -	-	1	10.0	- -	-	1	1.0	- -	-
GILINC	4	39.0	49.8 28.2	2.9	4	38.0	83.2 -7.2	53.9	4	1.8	2.8 0.7	13.0
GUTSAR	69	15.0	16.5 13.5	10.7	71	174.1	234.7 113.5	137.4	71	5.9	7.4 4.5	69.1

TABLE IV-3 (Cont.)

VEGETATION TYPE 3

Species	Height (cm)				Cover ($cm^2/4m^2$)				Density (individual/$4m^2$)			
	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE
HALGLO	6	4.3	5.6 3.0	6.1	18	34.2	54.5 13.8	60.4	18	19.8	29.4 10.3	60.4
HILJAM	23	17.6	21.4 13.8	15.9	23	378.4	595.0 161.9	111.0	23	5.7	8.0 3.5	52.0
ITTER	-	-	- -	-	1	1000.0	- -	-	1	1.0	- -	-
KOCAME	1	14.0	- -	-	1	200.0	- -	-	1	8.0	- -	-
LAPRED	10	4.9	5.7 4.1	3.8	11	5.2	8.2 2.2	48.6	11	5.2	6.2 4.2	5.7
LEPFRE	29	30.6	34.1 27.1	5.7	29	41.8	58.5 25.1	69.3	29	2.3	2.9 1.7	27.9
LEPIDT	1	8.0	- -	-	1	2.0	- -	-	1	1.0	- -	-
LEPMON	4	22.3	35.3 9.2	13.1	5	24.0	45.9 2.1	44.4	5	7.0	18.6 -4.6	146.2
LITTER	-	-	- -	-	196	445.0	489.4 400.5	31.3	196	1.0	1.0 1.0	-
MENALB	1	10.0	- -	-	1	2.0	- -	-	1	1.0	- -	-
OENCAE	8	3.6	4.1 3.1	1.8	10	34.3	51.8 16.8	34.3	10	1.7	2.2 1.2	10.2
OPURHD	18	8.7	10.1 7.3	6.6	18	100.3	133.1 67.6	27.6	18	1.5	1.8 1.2	11.9
ORYHYM	49	19.1	21.0 17.2	7.9	49	73.1	93.1 53.1	58.7	49	2.7	3.2 2.2	24.6
PHACEL	2	8.0	13.8 2.2	5.4	2	2.0	2.0 2.0	-	2	1.0	1.0 1.0	-
SALKAL	2	8.0	28.4 -12.4	66.3	17	16.1	22.9 9.3	43.5	17	13.8	19.8 7.9	44.7
SARVER	13	38.5	48.3 28.8	11.5	16	560.9	795.0 326.9	39.6	16	1.2	1.4 1.0	5.0
SARVERSD	-	-	- -	-	3	41.7	61.3 22.1	5.2	3	1.3	2.1 0.6	8.1

TABLE IV-3 (Cont.)

VEGETATION TYPE 3

Species	Height (cm)				Cover ($cm^2/4m^2$)				Density (individual/$4m^2$)			
	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE
SISALT	3	28.7	39.7 17.7	3.4	3	5.0	5.0 5.0	-	3	2.3	4.4 0.3	18.6
SISLIN	7	44.1	52.6 35.7	3.1	7	12.7	24.8 0.6	76.3	7	1.6	2.1 1.0	10.9
SITHYS	47	23.3	25.3 21.2	6.1	47	33.1	50.6 15.7	208.8	47	1.8	2.1 1.6	12.0
SPHCOC	34	11.1	12.7 9.6	10.8	35	56.1	102.2 9.9	379.1	35	1.9	2.3 1.6	18.8
SPHSUB	4	5.5	7.5 3.5	5.2	4	4.3	6.1 2.4	7.0	4	1.3	1.8 0.7	6.9
STEPAU	5	15.8	21.4 10.2	6.8	5	68.6	143.1 -5.9	62.8	5	2.2	3.2 1.2	10.7
STICOM	3	26.3	42.4 10.2	8.8	3	45.0	96.3 -6.3	30.5	3	1.7	2.5 0.9	5.2
SUANIG	4	27.5	37.7 17.3	5.2	4	337.5	744.3 -69.3	55.3	4	3.3	5.6 0.9	20.1
TETAXI	7	40.4	50.9 29.9	5.7	10	466.1	854.0 78.2	91.3	10	1.3	1.7 0.9	11.7
TETGLA	7	46.7	52.8 40.6	1.5	8	625.6	1066.7 184.6	49.7	8	1.6	2.4 0.8	23.1
TETSPI	25	38.7	42.8 34.6	4.1	25	908.2	1180.4 636.0	33.3	25	1.8	2.2 1.4	16.7
TETSPISD	-	-	- -	-	3	175.0	499.0 -149.0	80.4	3	1.3	2.1 0.6	8.1
TOWNSE	1	5.0	- -	-	1	3.0	- -	-	1	1.0	- -	-

Riparian (Vegetation Type 4)

Cover was the most extensive in riparian vegetation, although riparian areas were bare in contrast to the cover measured in 1975 (Table IV-4). Species adequately sampled for cover included *Populus fremontii* and *Chrysothamnus nauseosus*. A few other species that approached the set sampling intensity were *Artemisia tridentata*, *Bromus tectorum*, and *Scirpus americana*. Large areas of sparse grass or bare ground were encountered in 1976, a contrast to the dense vegetation of 1975.

Further discussion and comparisons of years and vegetation types will be included in the *Final Environmental Baseline Report*.

b. Productivity

Annual grasses and forbs were clipped and bagged from twenty 0.25-m^2 plots (within the larger 4-m^2 plots) per site, in 5 sites per vegetation type. The clippings were oven dried and weighed.

The mean annual grass production was greatest in the riparian vegetation type followed in decreasing order by sagebrush/greasewood, shadscale, and juniper (Table IV-5). Forb production was the most abundant in sagebrush/greasewood followed by riparian, juniper, and shadscale. Variability was extremely high in 1976, often greater than the mean value. In many plots there were no plants to clip, and thus the productivity values were low, particularly in juniper.

Compared with productivity in spring 1975 (Table IV-5), 1976 was a year of sparse plant growth. Few understory plants were found in juniper either year, but the 20-fold reduction in the riparian type represented significantly less food for wildlife and protective litter cover for soil.

c. Range-Condition Evaluation

Dr. Dwyer assessed range conditions in each vegetation type during June 1975 and observed several areas off the tracts for comparison. The off-tract areas were the north-facing slope of the side canyon entering Hell's Hole Canyon from the west; the high plateau on the north side of the White River; the area around the revegetation research site north

TABLE IV-4

RIPARIAN VEGETATION TYPE CHARACTERISTICS. Data are for the number of observations, mean, 90% confidence interval about the mean and sample size required to estimate within 25% of the mean with a 90% statistical confidence.

VEGETATION TYPE 4

Species	Height (cm)				Cover ($cm^2/4m^2$)				Density (individual/$4m^2$)			
	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE
ACHMIL	1	12.0	- -	-	1	5.0	- -	-	1	1.0	- -	-
AGOSER	1	14.0	- -	-	1	455.0	- -	-	1	23.0	- -	-
AGRINE	79	47.6	50.5 44.7	4.8	79	528.7	639.4 418.0	55.4	79	33.4	41.9 25.1	79.7
AGRREP	6	41.2	50.2 32.1	3.3	6	129.7	297.1 -37.8	114.7	6	20.3	28.5 12.1	11.2
AGRSMI	1	60.0	- -	-	1	350.0	- -	-	1	3.0	- -	-
ALOPRA	1	7.0	- -	-	1	200.0	- -	-	1	52.0	- -	-
AMBPSI	12	8.8	11.1 6.6	11.0	12	86.3	145.6 26.9	77.4	12	26.6	43.3 7.8	78.7
ARTTRI	14	111.8	132.8 90.8	6.9	17	2838.5	3629.3 2047.8	18.9	17	4.2	5.4 3.1	18.0
ATRCAN	3	85.3	178.9 -8.2	28.2	4	5025.0	14400.0 -4350.0	132.6	4	1.0	1.0 1.0	-
ATRPAT	65	16.5	18.2 14.8	11.6	65	110.4	163.8 57.0	243.5	65	17.9	26.7 9.1	252.1
BARGRO	0	-	- -	-	93	8347.8	10269.3 6426.3	78.8	93	1.0	1.0 1.0	-
BORAGI	2	18.5	31.6 5.4	5.1	2	7.5	14.8 0.2	9.6	2	2.5	4.0 1.0	3.5
BROTEC	139	25.1	26.5 23.8	6.4	140	1513.0	1909.3 1116.8	153.6	140	1265.9	1493.8 1038.1	72.5
CAREX	3	31.3	36.8 25.8	0.7	3	196.7	438.3 -45.0	35.4	3	10.0	17.0 2.9	11.7
CHADOU	2	6.0	3.9 3.1	2.4	2	5.5	18.6 -7.6	58.0	2	2.5	6.9 -1.9	31.2
CHOTEN	7	14.4	21.3 7.6	19.0	7	245.7	552.7 -61.3	131.7	7	58.4	143.2 -26.4	177.6
CHRNAU	55	86.7	95.9 77.6	9.8	61	1289.9	1592.5 987.3	53.7	61	1.7	1.9 1.4	22.0

TABLE IV-4 (Cont.)

VEGETATION TYPE 4

Species	Height (cm)				Cover (cm²/4m²)				Density (individual/4m²)			
	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE
CHRNAUSD	4	5.5	6.9 4.1	2.4	11	142.4	391.6 -106.9	452.4	11	2.5	3.9 1.1	47.9
CHRVIS	72	85.0	94.3 75.7	13.8	73	2540.7	3512.2 1569.2	170.8	73	4.7	5.4 4.0	25.9
CHRVISSD	-	-	- -	-	1	10.0	- -	-	1	2.0	- -	-
CIRSIU	10	16.8	24.9 8.8	30.3	10	256.8	531.7 -20.1	153.3	10	12.8	24.0 1.6	101.1
CLELIG	3	57.3	90.5 24.1	7.9	4	148.3	263.4 33.1	23.0	4	.1.8	3.4 0.1	31.8
CLELUT	11	26.8	32.1 21.6	5.6	11	18.4	24.7 12.0	17.6	11	2.1	2.8 1.4	16.7
COMPAL	49	17.6	18.9 16.3	4.5	49	121.7	166.7 76.7	107.3	49	20.6	28.9 12.2	129.3
CRYGRM	-	-	- -	-	3	993.3	1748.5 238.1	13.6	3	1.0	1.0 1.0	-
DISSTR	85	20.9	22.3 19.5	6.0	85	627.6	992.8 262.4	460.6	85	95.7	119.5 71.9	84.3
EQUARV	18	39.8	46.5 33.2	7.2	18	281.2	453.6 108.8	97.4	18	259.4	433.5 85.3	116.8
FESOCT	1	2.0	- -	-	1	360.0	- -	-	1	8351.0	- -	-
GILCON	2	16.5	53.0 -20.0	49.7	2	117.5	431.4 -196.4	72.5	2	14.5	45.2 -16.2	45.4
HALGLO	6	5.7	7.1 4.3	4.1	6	5.0	7.2 2.8	9.1	6	4.2	5.3 3.0	5.4
HORJUB	1	42.0	- -	-	1	20.0	- -	-	1	2.0	- -	-
JUNBAL	10	38.0	47.1 28.9	7.6	10	61.6	110.2 13.0	82.1	10	101.6	151.8 51.4	32.2
KOCSCO	30	8.6	10.3 7.0	16.6	30	167.5	275.6 59.4	187.7	30	203.0	402.5 3.4	435.8
LAPRED	6	19.2	28.2 10.1	15.4	6	18.0	34.0 2.0	54.4	6	16.0	26.9 5.1	31.8

TABLE IV-4 (Cont.)

VEGETATION TYPE 4

Species	Height (cm)				Cover ($cm^2/4m^2$)				Density (individual/$4m^2$)			
	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE
LEPFRE	1	35.0	- -	-	1	25.0	- -	-	1	4.0	- -	-
LEPIDT	34	28.3	34.1 22.4	23.1	34	61.2	116.7 5.6	448.6	34	17.6	22.7 12.4	47.4
LEPPER	24	13.9	17.5 10.3	23.4	24	192.6	374.5 10.7	316.5	24	126.0	221.6 30.4	204.2
LITTER	-	-	- -	-	195	31560.4	32759.6 30361.3	4.5	195	1.0	1.0 1.0	-
MALAFR	2	6.0	8.9 3.1	2.4	2	30.5	90.4 -29.4	39.1	2	26.0	40.6 11.4	.3.2
MELOFF	64	35.4	39.7 31.2	14.5	65	620.8	753.9 287.6	208.5	65	33.9	46.9 20.8	155.0
MULASP	1	15.0	- -	-	1	780.0	- -	-	1	26.0	- -	-
ORYHYM	4	25.8	39.6 11.9	11.0	4	1.5	2.1 0.9	6.4	4	2.0	3.5 0.5	21.6
PHACEL	6	12.8	16.9 8.8	6.9	6	153.7	383.3 -75.9	153.6	6	106.2	292.0 -79.6	210.7
PHRCOM	2	72.0	118.7 25.3	4.3	2	140.0	373.6 -93.6	28.3	2	21.0	76.5 -34.5	70.9
PLAPUR	3	9.3	15.0 3.7	8.6	3	7.3	11.5 3.2	7.5	3	9.0	15.8 2.2	13.4
POAPRA	29	61.0	66.7 55.3	3.7	29	820.9	1117.2 524.5	56.7	29	321.1	458.4 183.8	79.5
POASAN	2	27.0	88.3 -34.3	52.4	2	27.5	93.2 -38.2	58.0	2	2.0	4.9 -0.9	21.6
POPANG	-	-	- -	-	1	600.0	- -	-	1	1.0	- -	-
POPFRE	22	679.8	881.7 447.9	28.5	70	18557.7	21323.3 15792.1	24.9	70	1.6	1.8 1.3	37.6
RHUTRI	2	38.0	125.6 -49.6	54.0	2	617.5	2406.0 -1171.0	85.2	2	1.0	1.0 1.0	-
SALEXI	11	179.2	265.9 92.4	34.6	14	895.7	1496.9 294.5	88.0	14	1.5	2.1 0.9	31.8

TABLE IV-4 (Cont.)

VEGETATION TYPE 4

Species	Height (cm)				Cover ($cm^2/4m^2$)				Density ($individual/4m^2$)			
	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE	NUM OBS	MEAN	90% C.I.	SAMPLE SIZE
SALKAL	31	10.1	11.4 8.8	8.3	31	117.6	166.2 68.9	84.8	31	63.9	90.4 37.4	85.4
SARVER	13	106.1	140.1 72.0	18.5	21	3804.9	5597.9 2012.0	68.1	21	1.1	1.2 1.0	3.3
SARVERSD	-	-	- -	-	1	3.0	- -	-	1	1.0	- -	-
SCIAME	3	34.3	47.0 21.7	3.2	3	52.0	155.9 -52.0	93.8	3	8.0	16.3 -0.3	25.0
SISLIN	1	34.0	- -	-	1	30.0	- -	-	1	29.0	- -	-
SITHYS	3	59.0	67.5 50.5	0.5	3	406.7	508.6 304.7	1.5	3	10.3	16.0 4.7	7.0
SPOAIR	13	29.4	34.4 24.4	5.3	13	617.7	851.7 383.7	25.7	13	2.2	3.0 1.5	20.5
SPOCRY	5	13.4	19.2 7.6	9.8	5	21.0	35.0 7.0	23.8	5	3.4	6.4 0.4	40.4
STEPAU	1	10.0	- -	-	1	5.0	- -	-	1	3.0	- -	-
TAMPEN	32	320.8	385.9 255.7	21.1	38	3141.9	4598.3 1685.6	130.6	38	4.5	5.8 3.2	52.8
TAMPENSD	1	7.0	- -	-	1	15.0	- -	-	1	3.0	- -	-
TAROFF	23	14.7	18.2 11.2	19.7	23	570.5	938.7 202.2	141.2	23	21.6	36.1 7.1	152.8
TRADUB	7	48.0	55.1 40.9	1.8	7	14.9	18.4 11.4	4.7	7	2.4	3.2 1.6	9.4
XANSTR	1	8.0	- -	-	1	15.0	- -	-	1	1.0	- -	-

TABLE IV-5

ANNUAL GRASS AND FORB PRODUCTION IN JUNE, 1976
(Dry Weights in Grams per m^2)

	Vegetation Type			
	Sagebrush-Greasewood	Juniper	Shadscale-Sagebrush	Riparian
Grass				
Site 1	36.52	0.04	0.02	34.48
2	7.60	0.08	6.22	50.68
3	13.55	-	0.10	31.12
4	1.06	-	-	0.28
5	-	-	12.16	9.58
Mean ($\bar{x}$)	11.75	0.02	3.70	25.23
S.D.	14.89	0.04	5.43	20.22
Frequency 1/	36	4	38	63
(1975 mean)	(47.77)	(7.58)	(173.10)	(533.25)
Forb				
Site 1	1.24	0.24	-	6.48
2	-	0.18	0.16	2.64
3	44.62	0.14	0.30	0.38
4	-	0.60	0.02	3.12
5	-	-	0.16	14.08
Mean ($\bar{x}$)	9.17	0.23	0.13	5.34
S.D.	19.82	0.22	0.12	5.35
Frequency	20	9	19	45
(1975 Mean)	(13.33)	(1.22)	(51.20)	(56.71)
Total (grass + forb) Production				
Mean	20.92	0.25	3.83	30.57
(1975 mean)	(51.10)	(8.80)	(224.30)	(589.96)

1/ Frequency = number of plots out of a possible 100 plots in which harvests were made.

of the White River; and Asphalt Wash west of the tracts. Dr. Dwyer's evaluation is as follows:

Based on the assessment of the four vegetation types, the overall range condition of the tracts is poor. The only vegetation type in higher range condition is the riparian type, which is in fair condition.

The vegetation types are marked by sharp boundaries evidenced in soil-type changes and slope exposure. The climate of the area is harsh, with hot, dry, windy summers and cold, snowy winters. The plant mix is mostly cold-desert species, although there are some warm-season plants.

Because of the generally favorable climatic conditions of the past two years, the trend is toward stable to slightly improved range conditions; however, the evidence is not strong that the long-term trend is upward. There are numerous shadscale and sagebrush seedlings among the grass species. There is very little indication of grass reproduction, although in certain areas some seedlings of Sitanion hystrix and Stipa comata are present.

Sheep trails are an obvious part of the landscape throughout the tracts and serve as strong documentation that current use of the area by sheep is excessive. Throughout the tracts the plants are hedged from browsing, and grass plants and grass species are extremely scarce. Where they do exist they are protected from grazing because they grow within the shrubs.

Bromus tectorum is a common and widespread constituent of all plant communities. It is the most abundant on heavier soils and responds primarily to seasonal precipitation patterns. Average to above average early spring moisture results in heavy stands of this cool-season annual. Halogeton glomeratus was another very common annual throughout the tracts.

There is only one location--on a northeast-facing slope--with good range conditions. Grass was common on the site: Agropyron inerme was the most abundant; and Stipa comata, Oryzopsis hymenoides, Sitanion hystrix, and Poa sandbergii were common throughout the openings among the shrubs. Shadscale and sagebrush were the most abundant shrubs, with Forselesia glossypetalon widely scattered. The latter shrub is a highly preferred plant by both sheep and deer. Ceratoides lanata was also widespread on the site. All grass species and shadscale were reproducing, and sagebrush was producing seedlings to a lesser extent. There was no visible evidence of current erosion and sheep trails were barely visible.

The tracts are not abused beyond recovery. Winter grazing has allowed the shrub component of the vegetation to survive, but late-spring grazing has been extremely detrimental to the grasses. Reduced grazing pressure and an earlier end to grazing each year, around May 10, could improve the range considerably.

Four vegetation types are represented on the tracts: sagebrush/greasewood, shadscale/sagebrush, pinyon/juniper, and riparian. Sagebrush/greasewood covers an estimated 25% of the tracts. It occurs on the heavier soils at lower elevations and on the drainageways around the shale hills. Sagebrush is the dominant plant, with greasewood increasing in importance on the heavier soils. This plant community is open, with very little herbaceous understory vegetation. Most of the sagebrush plants are hedged from sheep grazing, and very few plants in the community do not show signs of recent grazing. Very few grass plants are present in this type. Occasionally *Sitanion hystrix* can be found within the protective canopy of sagebrush or other shrubs, and on rare occasions *Oryzopsis hymenoides* is found in similar locations.

Sheep trails are obvious throughout this type because of the pulverized soil in and near the trails. Erosion is widespread and active, and no litter has accumulated except deep within sagebrush canopies. Very little reproduction of desirable plants was observed, although some sagebrush reproduction was apparent.

Foliar cover is low in sagebrush/greasewood, and much of the soil surface is exposed. Overall productivity is relatively low as a result of the generally low state of vigor exhibited by the plants. The range conditions over the tracts is generally high poor to low fair, although the favorable climatic conditions the past two springs have improved conditions slightly.

Shadscale/sagebrush is widespread throughout the tracts, covering 35% to 40% of the area, in the soils of loose shale outcroppings. Shadscale, the dominant species, occurs in a pure stand on hot, dry, south-facing and west-facing slopes to about an even mix with sagebrush as the soil changes from shale outcropping to a finer texture.

Shadscale has survived the past decades of heavy grazing, even though it is a plant preferred by sheep for winter grazing. Shadscale has declined in abundance, however, despite its tenacity, and sagebrush has increased. Both shadscale and sagebrush are heavily grazed. Other shrubs found in this vegetation type are *Chrysothamnus viscidiflorus*

and C. greenii, and in pockets of heavier soil, Sarcobatus vermiculatus and Tetradymia spp.

Grasses are rare in shadscale/sagebrush, although Sitanion hystrix, Oryzopsis hymenoides, Agropyron inerme, and Stipa comata occur under the protection of shrubs. On outwashed areas on lower elevations, Sporobolus cryptandrus and Hilaria jamesii appear on finer textured soils. There are very few forbs.

Sheep trails are further evidence of grazing pressure in this plant community. In addition, the ridgetops in shadscale/sagebrush are favorite sheep bedding grounds, which adds further pressure from sheep activities.

The shale-exposed surface protects the community from excessive erosion. Any soil that may have been present on the hillsides in the past has long since vanished. Throughout this type many dead shadscale and some, but fewer, dead sagebrush plants were observed. It is assumed the plants have succumbed as a result of excessive grazing and attendant causes, such as reduced plant resistance to disease and insect damage. Very little bud sage (Artemisia spinescens) and no fourwing saltbush (Atriplex canescens) was seen, although both of these plants are usually common in this vegetation type.

The range condition of the shadscale/sagebrush type is mid to high poor. The trend is static to slightly upward, as evidenced by the numerous shadscale and sagebrush seedlings, but there is little else to substantiate an upward trend in range condition.

Pinyon/juniper occurs on sandstone outcrops at the upper elevations on about 35% to 40% of the tracts, usually above 5500 ft. The communities in this area are representative of this important western vegetative type. There are very few pinyon pine, probably less than 5% of the tree canopy, and the juniper trees display a distorted growth habit, indicating its rather marginal existence.

There is very little understory vegetation, and erosion is widespread and active. Grasses and forbs are almost non-existent, though Hilaria jamesii does occasionally occur on the heavier soils. At the lower elevations, sagebrush mingles with juniper on the finer textured soils in the draws and bottomlands. Artemisia nova and A. parryi are found in some areas with the juniper, primarily in the openings. The juniper trees have well-defined browse lines at the convenient grazing height for sheep.

Pinyon/juniper on the tracts is generally in poor to very poor condition. The trend is static to downward; in fact, in most of the locations observed, range conditions could not be much worse.

Riparian vegetation occurs along the main water courses on the tracts. This type covers the smallest area of any of the major vegetation types--about 5% to 8% of the tract area--although it is the most complex and diverse. It is also the most productive on the tracts and appears to be fairly stable. Its condition and status depend largely on the fluctuating water levels of the rivers and tributaries.

The range condition of the riparian area is high fair. The trend is stable, and there is evidence of activity of man and animals.

d. Sagebrush Stem Growth

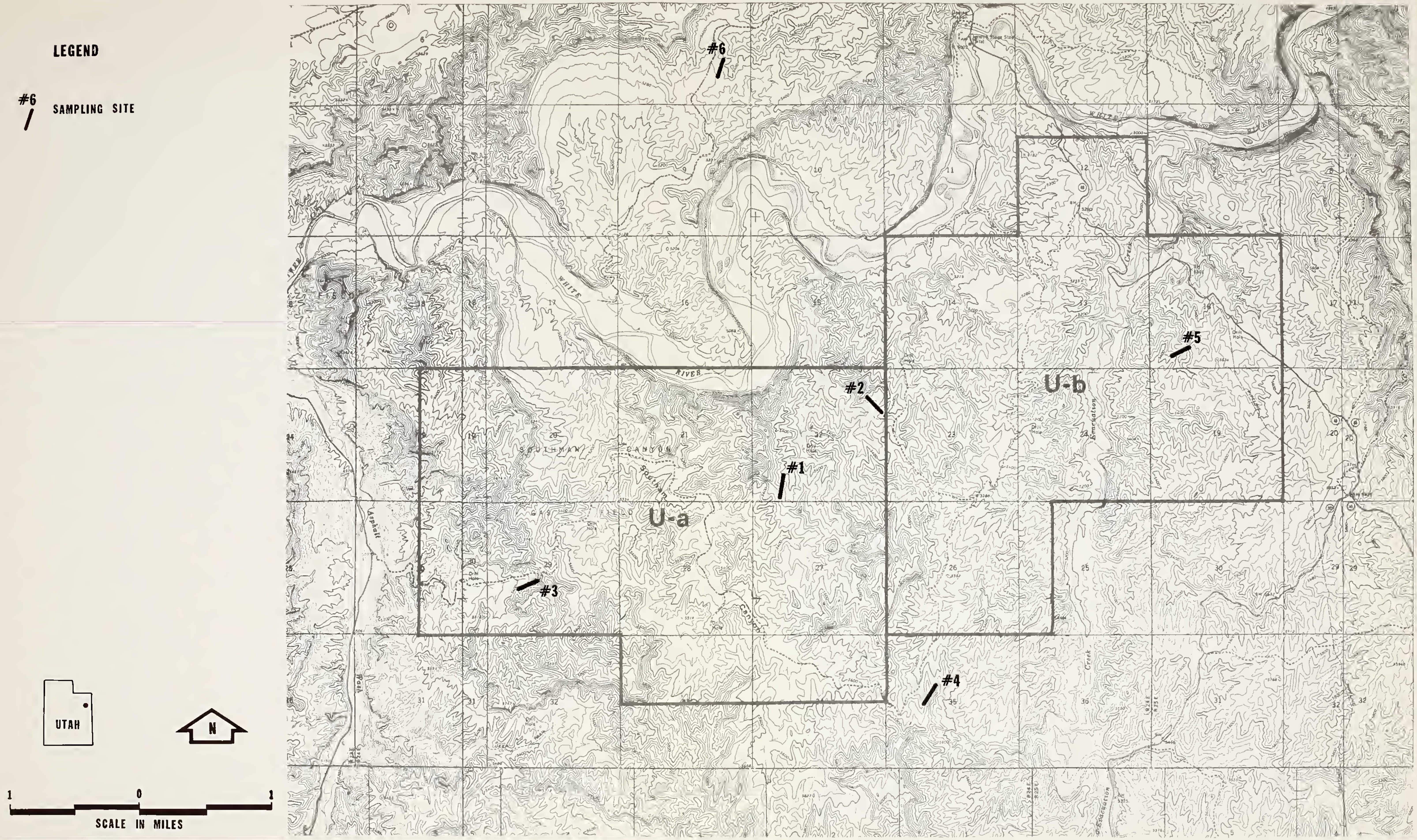
As a possible index of site or yearly productivity, 1975 sagebrush-stem growth was measured in June 1976. Even though there was considerable new growth in 1976, it was possible to identify growth of the previous year by measuring back from the bud-scale scars at the base of present growth to the bud-scale scars at the base of 1975 stem growth.

Plant scientists in the field have often noted that leader growth (or current stem elongation) in a given year closely reflects the favorability of a given site in a given year. Limited data gathering was conducted in an effort to determine whether this phenomenon could be used as an index of site favorability (conditions) in an area subject to industrial development, such as an oil-shale retort, and contrasted with favorability in an area not influenced by development. To be effective an index measurement should reflect (or integrate) conditions favorable or unfavorable to growth from year to year, and the index should have a relatively low statistical variability. Another criteria is that a species chosen for measurement should have a fairly widespread distribution. Sagebrush-stem growth appeared to satisfy these requirements and was chosen for measurement.

Six sites for sagebrush-stem measurement was selected. Two sites were in the immediate vicinity of the area designated for location of the retorting facilities in Section 22, and four were in perimeter areas west, east, south, and north of the proposed retort site (Figure IV-1).

LEGEND

#6 SAMPLING SITE



SAMPLING SITES - SAGEBRUSH STEM GROWTH

1975 - 1976

FIGURE IV-1

In each site, 20 sagebrush plants were selected along a transect and 10 stems were measured on each plant. In all a total of 1800 stems were measured. The criteria used to select stems for measurement were simply that stems must be ungrazed and be the longest stems in a group of stems on a branch of the plant. No attempt was made to select typical stems.

The average new-stem length in 1975 varied considerably from plant to plant (Table IV-6), with the standard deviation of the means representing about one quarter of the mean value. Sagebrush-stem length appeared to be longer on plants in site 3 than in sites 4 and 6. Whether these differences will remain consistent in measurements of 1976 growth will determine the usefulness of the current year's stem growth as an index of comparison. As shown on Table IV-5, only sites with similar stem lengths, such as site 4 and 6, could be used to compare the effects of site influence and non-influence from retorting or other industrial effects. The best pair of sites appear to be sites 2 and 5, which would provide a comparison of impacted and non-impacted comparison.

2. TERRESTRIAL VERTEBRATES

a. General

June 1975 followed a cold, wet spring that produced an abundance of flowers, insects, and birds. The 78 species of birds observed on the tracts included large raptors such as golden eagles and great-horned owls and small birds such as broad-tailed hummingbirds and black-tailed gnatcatchers. Other species recorded were mountain bluebirds, lazuli bunting, house finches, western tanagers, three species of vireos and nine species of warblers, numerous cliff swallows, and mourning doves (Table IV-7).

In all, 1411 individual birds were seen on flushing transects. In the riparian habitat an estimated 21 birds occupied 1 ha of land (100 x 100 m). In the greasewood washes leading away from the river, 11 birds occupied 1 ha of land. In the upland juniper forest, there were an estimated six birds per ha, and in the shadscale, five birds per ha (Table IV-8).

In June 1976, following a warm, dry spring, insects and birds were less abundant. Seventy-eight species were again present, 67 of which had been observed in 1975. Absent were the widgeon, yellow-bellied sapsucker, canyon wren,

TABLE IV-6

Mean sagebrush leader length for 1975 at six selected sites. Length in cm and one standard deviation are reported. Means are from 10 observations.

Plant No.	Site Number (see map for location)											
	1		2		3		4		5		6	
	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
1	8.43	3.122	6.92	1.694	7.37	2.001	7.25	1.492	10.33	2.751	3.91	0.812
2	3.78	1.500	6.71	2.106	7.82	2.208	4.52	0.893	9.22	1.711	4.52	1.592
3	7.17	4.586	5.44	1.969	6.28	1.634	5.49	1.130	5.12	1.209	3.61	0.880
4	8.28	1.253	6.41	2.221	10.17	3.317	6.57	1.738	6.76	1.486	4.15	1.214
5	7.22	2.624	7.59	1.948	8.01	2.924	5.23	1.218	5.39	1.462	7.16	1.019
6	3.80	1.789	9.16	2.672	11.83	2.293	5.49	1.037	8.21	1.693	6.45	1.474
7	7.29	1.891	7.43	2.486	11.13	3.711	5.86	1.136	6.34	1.786	7.77	1.649
8	6.65	1.953	8.45	1.473	9.29	2.826	3.75	0.958	5.08	2.047	5.79	1.429
9	5.97	1.374	6.33	2.504	8.49	1.446	6.51	1.316	7.77	1.991	6.75	1.950
10	12.41	4.386	7.89	3.062	11.63	3.760	4.72	1.904	7.08	0.985	3.78	0.859
11	9.79	2.440	5.96	2.262	11.36	4.789	5.94	1.857	6.81	2.008	5.16	1.530
12	7.68	4.216	8.14	2.651	8.39	1.976	4.11	0.862	8.75	1.034	4.07	1.280
13	11.08	2.217	7.56	1.711	9.87	2.331	7.56	1.938	6.67	1.446	3.59	0.703
14	8.92	1.526	6.49	1.417	12.20	2.208	5.81	1.061	7.39	1.632	4.20	0.888
15	6.71	1.554	7.94	2.422	7.53	0.902	6.61	1.259	7.68	1.987	6.93	1.835
16	4.96	1.544	6.97	2.896	11.12	3.640	4.25	1.002	6.86	1.423	7.69	2.392
17	7.06	1.836	7.45	1.952	12.60	2.155	6.18	1.205	6.55	1.967	6.64	1.813
18	5.83	3.117	4.04	1.244	7.98	2.103	5.71	1.311	6.99	2.016	7.07	1.967
19	7.14	1.029	7.19	2.656	10.71	3.671	4.73	0.966	7.68	1.963	4.32	1.834
20	7.81	3.220	5.08	1.201	10.04	2.492	5.74	1.550	6.35	2.048	3.76	1.208
Site mean, S.D.	7.399	2.135	6.958	1.212	9.691	1.859	5.602	1.033	7.151	1.313	5.366	1.530
Overall mean SD	7.028	1.552										

TABLE IV-7

AVIAN SPECIES LIST, DISTRIBUTION, AND STATUS ON OR WITHIN 1.6 KM (1 mi) OF UTAH OIL SHALE TRACTS, JUNE AND AUGUST, 1976

X = bird observed, G = greasewood, J = juniper, S = shadscale, R = riparian
p = permanent resident, year round occurrence, s = summer resident, nests in area, migrates during winter
t = transient, passes through area

Bird (Order/Species)	Date: June 1976 Vegetation Type G	J	S	R	August 1976 Vegetation Type G	J	S	R	Status
Ciconiformes									
Great Blue Heron	-	-	-	x	-	-	-	x	s
Anseriformes									
Canada Goose	-	-	-	x	-	-	-	-	s
Mallard	-	-	-	x	-	-	-	-	
Gadwall	-	-	-	x	-	-	-	x	
Green-winged Teal	-	-	-	x	-	-	-	?	
Northern Shoveler	-	-	-	x	-	-	-	-	
Falconiformes									
Turkey Vulture	-	-	-	x	-	-	x	x	s
Sharp-shinned Hawk	-	-	-	-	-	-	-	?	
Cooper's Hawk	-	-	-	x	-	-	-	x	p
Red-tailed Hawk	x	x	x	x	x	x	x	x	s
Swainson's Hawk	-	-	-	-	-	-	x	x	
Golden Eagle	x	x	x	x	x	x	x	x	p
Marsh Hawk	-	-	x	-	x	-	x	-	p
Prairie Falcon	x	-	x	x	-	-	-	x	s
American Kestrel	x	x	x	x	x	x	x	-	s
Galliformes									
Ring-necked Pheasant	x	-	-	x	-	-	-	-	
Charadriiformes									
Spotted Sandpiper	-	-	-	x	-	-	-	x	s
Killdeer	-	-	-	x	-	-	-	-	s
Columbiformes									
Mourning Dove	x	x	x	x	x	x	x	x	s
Strigiformes									
Great Horned Owl	-	-	-	x	-	-	-	x	p
Caprimulgiformes									
Poor-will	-	-	?	-	-	-	?	-	
Common Nighthawk	x	x	x	x	x	x	x	x	s
Apodiformes									
White-throated Swift	x	-	x	x	-	-	-	-	s
Broad-tailed Hummingbird	x	x	x	x	-	?	?	-	s
Piciformes									
Common Flicker (Red-shafted)	x	x	-	x	-	x	-	x	p
Williamson's Sapsucker	-	-	-	-	-	?	-	-	
Hairy Woodpecker	-	-	-	-	-	-	-	x	p
Downy Woodpecker	-	-	-	-	-	-	-	x	p
Passeriformes									
Eastern Kingbird	-	-	-	x	-	-	-	x	s
Western Kingbird	-	-	x	x	x	-	-	x	s
Ash-throated Flycatcher	-	-	x	x	x	-	-	x	s
Say's Phoebe	x	x	x	x	x	-	-	x	s
Willow Flycatcher (Traill's)	-	-	-	x	-	-	-	?	s
Gray Flycatcher	x	x	-	x	-	x	-	-	s
Western Wood Pee Wee	-	-	-	x	-	-	-	-	s
Horned Lark	-	-	x	-	-	-	x	-	p
Violet-green Swallow	x	-	-	x	-	-	x	x	s
Rough-winged Swallow	x	-	-	-	-	-	-	x	s
Cliff Swallow	x	x	x	x	-	-	-	x	s
Scrub Jay	-	-	-	-	-	x	-	x	p
Black-billed Magpie	x	x	x	x	x	x	x	x	p
Common Raven	-	x	-	-	-	-	x	x	p

TABLE IV-7(Cont.)

AVIAN SPECIES LIST, DISTRIBUTION, AND STATUS ON OR WITHIN 1.6 KM (1 mi) OF UTAH OIL SHALE TRACTS, JUNE AND AUGUST, 1976

X = bird observed, G = greasewood, J = juniper, S = shadscale, R = riparian
p = permanent resident, year round occurrence, s = summer resident, nests in area, migrates during winter
t = transient, passes through area

	Date								
	June 1976 Vegetation Type				August 1976 Vegetation Type				
Bird (Order/Species)	G	J	S	R	G	J	S	R	Status
Piñon Jay	x	x	x	x	x	x	x	x	p
Black-capped Chickadee	-	-	-	x	-	-	-	x	p
Mountain Chickadee	-	?	-	-	-	-	-	-	
Plain Titmouse	-	x	-	-	-	x	-	-	p
Bushtit	-	x	-	-	-	-	-	-	s
White-breasted Nuthatch	-	-	-	-	-	-	-	x	
Red-breasted Nuthatch	-	-	-	-	-	x	-	-	
House Wren	-	-	-	-	x	-	-	-	
Bewick's Wren	-	-	-	?	-	-	-	-	
Rock Wren	x	x	x	x	x	x	x	x	s
Mockingbird	x	-	-	-	-	-	-	-	s
Bendive's Thrasher	-	-	?	-	-	-	-	-	
Sage Thrasher	x	-	x	-	x	-	x	-	s
American Robin	-	-	-	x	x	-	-	x	s
Hermit Thrush	-	-	-	-	-	-	-	x	
Mountain Bluebird	x	x	x	x	x	x	-	x	s
Blue-gray Gnatcatcher	x	x	-	x	-	x	-	x	s
Cedar Waxwing	-	-	-	x	-	-	-	-	
Loggerhead Shrike	x	-	x	-	x	-	x	x	p
Starling	-	-	-	x	-	-	-	-	s
Warbling Virco	-	-	-	x	-	-	-	x	s
Yellow Warbler	-	-	-	x	-	-	-	x	s
Yellow-rumped Warbler (Audubon's)	x	x	-	x	-	-	-	-	s
Black-throated Gray Warbler	x	x	-	x	-	x	-	-	s
MacGillivray's Warbler	-	-	-	x	-	-	-	-	s

	Date								
	June 1976 Vegetation Type				August 1976 Vegetation Type				
Bird (Order/Species)	G	J	S	R	G	J	S	R	Status
Common Yellowthroat	-	-	-	x	-	-	-	-	s
Yellow-breasted Chat	-	-	-	x	-	-	-	x	s
Western Meadowlark	x	-	x	x	-	-	x	x	s
Red-winged Blackbird	-	-	-	x	-	-	-	-	s
Scott's Oriole	x	-	-	-	x	-	-	x	s
Northern Oriole (Bullock's)	-	-	-	x	-	-	-	-	s
Brewer's Blackbird	x	-	x	x	-	-	-	-	s
Brown-headed Cowbird	-	-	x	x	-	-	-	x	s
Western Tanager	-	-	-	x	-	x	-	x	s
Rose-breasted Grosbeak	-	x	-	-	-	-	-	-	
Black-headed Grosbeak	-	-	-	x	-	-	-	x	s
Blue Grosbeak	-	-	-	x	-	-	-	x	s
Lazuli Bunting	x	x	-	x	-	-	-	-	s
House Finch	x	x	x	x	-	x	x	x	s
American Goldfinch	-	-	-	x	-	-	-	-	s
Green-tailed Towhee	-	-	-	-	-	-	-	x	
Rufous-sided Towhee	x	-	-	x	x	-	x	x	s
Lark Sparrow	x	x	x	x	x	-	-	-	s
Black-throated Sparrow	x	x	x	-	x	-	x	x	s
Sage Sparrow	-	-	x	-	-	-	x	-	s
Gray-headed Junco	x	x	-	-	-	-	-	-	
Chipping Sparrow	x	x	-	-	x	-	-	x	s
Brewer's Sparrow	x	x	x	-	x	x	-	x	s
White-crowned Sparrow	-	-	-	x	-	-	-	-	s
Song Sparrow	-	-	-	x	-	-	-	-	s

TABLE IV-8

AVIAN DENSITIES IN THE FOUR MAJOR HABITAT TYPES DURING THE SUMMER OF 1975 AND 1976

		June						August					
		1975		1976		Density Change, %		1975		1976		Density Change, %	
		Density						Density					
		Number		Number				Number		Number			
Vegetation Type	Bird (Species)	Observed	Per ha	Observed	Per ha	Observed	Per ha	Observed	Per ha	Observed	Per ha	Observed	Per ha
Greasewood	Golden Eagle	-	-	-	-			-	-	4	-		
	Prairie Falcon	1	-	-	-			-	-	-	-		
	American Kestrel	-	-	2	-			-	-	-	-		
	Mourning Dove	12	0.4	10	0.5	-17	+25	95	3	3	0.1	-97	-97
	White-throated Swift	2	-	-	-			-	-	-	-		
	Common Flicker	-	-	1	-			-	-	-	-		
	Eastern Kingbird	1	-	-	-			-	-	-	-		
	Ash-throated Flycatcher	-	-	-	-			-	-	3	-		
	Say's Phoebe	1	-	1	-			16	0.5	4	0.2	-75	-62
	Gray Flycatcher	4		-	-			1	-	-	-		
	Violet-green Swallow	-	-	4	0.3			6	0.6	-	-		
	Black-billed Magpie	5	0.1	3	0.2			-	-	-	-		
	Piñon Jay	41	4	9	-	-78		34	2.4	77	5.3	+126	+121
	Plain Titmouse	3	-	-	-			-	-	-	-		
	House Wren	-	-	-	-			-	-	1	-		
	Cañon Wren	1	-	-	-			-	-	-	-		
	Rock Wren	22	0.4	9	0.4	-59	0	31	0.5	3	-	-90	
	Mockingbird	-	-	15	0.4	+		-	-	-	-		
	Sage Thrasher	-	-	-	-			3	-	2	-		
	Mountain Bluebird	7	-	-	-	-		-	-	2			
	Black-tailed Gnatcatcher	2	-	-	-			-	-	-	-		
	Loggerhead Shrike	4	0.1	11	0.1	-175	0	6	0.2	4	0.1		
	Black-throated Gray Warbler	-	-	1	-			-	-	-	-		
	Western Meadowlark	10	0.3	12	0.2	+20	-33	4	0.2	11	0.4		
	Red-winged Blackbird	4	-	-	-			-	-	-	-		
	Scott's Oriole	-	-	-	-			-	-	1	-		
	Brewer's Blackbird	25	0.6	-	-	-		-	-	-	-		
	Western Tanager	1	-	-	-			-	-	-	-		
	House Finch	3	0.3	9	0.7			-	-	-	-		
	Rufous-sided Towhee	-	-	2	-			1	-	1	-		

TABLE IV-8 Cont.

AVIAN DENSITIES IN THE FOUR MAJOR HABITAT TYPES DURING THE SUMMER OF 1975 AND 1976

Vegetation Type	Bird (Species)	June 1975 Number Observed	June 1975 Density Per ha	June 1976 Number Observed	June 1976 Density Per ha	June Density Change, % Observed	June Density Change, % Per ha	August 1975 Number Observed	August 1975 Density Per ha	August 1976 Number Observed	August 1976 Density Per ha	August Density Change, % Observed	August Density Change, % Per ha
Greasewood (cont.)	Lark Sparrow	7	0.5	5	0.2			9	0.1	1	-	-89	
	Black-throated Sparrow	18	0.9	23	0.9	+28	0	11	0.4	13	0.9	+18	+125
	Sage Sparrow	-	-	1	-			49	1.2	2	0.2	-96	-83
	Chipping Sparrow	23	1.4	-	-	-		-	-	11	0.6	+	
	Brewer's Sparrow	51	1.7	8	0.3	-84	-82	64	4.8	10	0.4	-84	-89
	White-crowned Sparrow	1	-	-	-			-	-	-	-		
	Total	249	10.7	126	4.2	-49	-61	330	13.9	153	8.2	-54	-41
	Species Total	24		18				14		18			
Juniper	American Kestrel	3	-	-	-			1	-	-	-		
	Mourning Dove	22	0.5	11	0.5	-50	0	16	0.5	-	-	+	
	Common Nighthawk	1	-	-	-			-	-	-	-		
	Broad-tailed Hummingbird	-	-	1	-			-	-	-	-		
	Common Flicker	-	-	2	-			-	-	1	-		
	Say's Phoebe	1	-	2	-			-	-	2	-		
	Gray Flycatcher	12	0.4	15	0.2	+25	-50	2	-	1	-		
	Western Wood Peewee	1	-	-	-			1	-	-	-		
	Cliff Swallow	-	-	3	-			-	-	-	-		
	Scrub Jay	1	-	-	-			-	-	-	-		
	Black-billed Magpie	7	0.3	8	0.1			-	-		-		
	Common Raven	-	-	1	-			-	-				
	Piñon Jay	25	1.4	43	4.0	+72	+186	17	1.5	71	2.5	+318	+67
	Plain Titmouse	-	-	15	0.7	+		-	-	-	-		
	Bushtit	-	-	1	-			-	-	-	-		
	Red-breasted Nuthatch	-	-	-	-			-	-	1	-		
	Rock Wren	17	0.4	10	0.2	-41	-50	12	0.3	5	0.1	-58	-67
	Sage Thrasher	1	-	-	-			-	-	-	-		
	Mountain Bluebird	14	0.1	-	-			-	-	14	0.6	+	
	Blue-gray Gnatcatcher	-	-	9	0.2	+		2	-	-	-		

TABLE IV-8

AVIAN DENSITIES IN THE FOUR MAJOR HABITAT TYPES DURING THE SUMMER OF 1975 AND 1976

Vegetation Type	Bird (Species)	June 1975 Number Observed	June 1975 Density Per ha	June 1976 Number Observed	June 1976 Density Per ha	June Density Change, % Observed	June Density Change, % Per ha	August 1975 Number Observed	August 1975 Density Per ha	August 1976 Number Observed	August 1976 Density Per ha	August Density Change, % Observed	August Density Change, % Per ha
Juniper (cont.)	Black-tailed Gnatcatcher	2	-	-	-			-	-	-	-		
	Loggerhead Shrike	-	-	4	-			-	-	1	-		
	Black-throated Gray Warbler	19	0.4	15	0.6	-21	+33	-	-	-	-		
	Western Meadowlark	1	-	-	-			-	-	-	-		
	Brewer's Blackbird	2	-	-	-			-	-	-	-		
	Brown-headed Cowbird	4	-	5	-			-	-	-	-		
	Western Tanager	1	-	-	-			-	-	-	-		
	House Finch	26	0.7	23	0.6	-11	-14	-	-	2	-		
	Lark Sparrow	4	-	9	0.2			-	-	-	-		
	Black-throated Sparrow	11	0.3	15	0.6	+36	+100	6	0.2	2	-		
	Sage Sparrow	2	-	-	-			1	-	-	-		
	Chipping Sparrow	25	1.8	13	0.4	-48	-78	32	0.7	1	-	-97	
	Brewer's Sparrow	6	0.2	-	-			12	0.2	1	0.1	-92	
	Total	208	6.5	205	8.3	-1	+28	102	3.4	102	3.3	0	-3
	Species Total	24		20				11		12			
Shadscale	Red-tailed Hawk	1	-	-	-			-	-	-	-		
	American Kestrel	1	-	-	-			2	-	2	-		
	Mourning Dove	8	0.7	9	0.2	+12	-71	15	1.1	1	-	-93	
	Common Nighthawk	-	-	-	-			-	-	1	-		
	Broad-tailed Hummingbird	-	-	1	-			-	-	-	-		
	Western Kingbird	-	-	1	-			-	-	-	-		
	Say's Phoebe	4	0.2	-	-			-	-	-	-		
	Horned Lark	-	-	1	-			-	-	1	-		
	Violet-Green Swallow	1	-	-	-			-	-	-	-		
	Rough-winged Swallow	-	-	-	-			16	1.6	-	-	-	
	Piñon Jay	-	-	-	-			-	-	77	0.8	+	
	Rock Wren	12	-	1	-	-92		5	-	3	-		
	Sage Thrasher	8	-	7	-	-12		3	-	2	-		

TABLE IV-8 Cont.

AVIAN DENSITIES IN THE FOUR MAJOR HABITAT TYPES DURING THE SUMMER OF 1975 AND 1976

Vegetation Type	Bird (Species)	June 1975 Density Number Observed	June 1975 Density Number Per ha	June 1976 Density Number Observed	June 1976 Density Number Per ha	June Density Change, % Observed	June Density Change, % Per ha	August 1975 Density Number Observed	August 1975 Density Number Per ha	August 1976 Density Number Observed	August 1976 Density Number Per ha	August Density Change, % Observed	August Density Change, % Per ha
Shadscale (cont.)	Mountain Bluebird	6	0.1	-	-			-	-	-	-		
	Loggerhead Shrike	6	0.1	14	0.1	+133	0	11	0.1	8	0.3	-27	+200
	Western Meadowlark	41	0.6	26	0.5	-36	-17	12	0.7	18	0.6	+50	-14
	Brewer's Blackbird	1	-	-	-			-	-	-	-		
	House Finch	-	-	1	-			-	-	-	-		
	Rufous-sided Towhee	-	-	-	-			-	-	3	-		
	Lark Sparrow	12	0.2	27	1.2	+125	+500	8	0.5	-	-		
	Black-throated Sparrow	10	0.1	9	0.5	-10	+400	8	0.1	2	-	-75	
	Sage Sparrow	24	1.4	14	0.5	-41	-64	10	0.5	28	1.1	+180	+120
	Brewer's Sparrow	27	1.4	7	0.2	-74	-86	4	0.3	-	-		
	Total	162	4.8	117	3.2	-28	-33	94	4.9	146	2.8	+55	-43
	Species Total	15		13				11		12			
Riparian	Great Blue Heron	-	-	-	-			-	-	2	-		
	Canada Goose	2	-	-	-			-	-	-	-		
	Green-winged Teal	-	-	3	-			-	-	-	-		
	Turkey Vulture	9	0.3	-	-	-		-	-	-	-		
	Cooper's Hawk	-	-	-	-			1	-	1	-		
	Red-tailed Hawk	-	-	1	-			1	-	3	-		
	Golden Eagle	3	-	-	-			-	-	4	0.1		
	Prairie Falcon	-	-	1	-			-	-	-	-		
	American Kestrel	-	-	4	0.1			-	-	-	-		
	Spotted Sandpiper	8	0.1	14	0.4	+75	+300	6	0.1	5	0.3		
	Killdeer	-	-	-	-			5	0.5	-	-		
	Mourning Dove	34	0.8	16	1.6	-52	+100	37	2.7	6	0.3	-84	-89
	Common Nighthawk	-	-	-	-			-	-	3	-		
	White-throated Swaift	-	-	3	-			-	-	-	-		
	Broad-tailed Hummingbird	1	-	2	-			-	-	-	-		
	Common Flicker	3	0.1	3	0.1			5	0.4	26	1.2	+420	+200
	Hairy Woodpecker	-	-	-	-					1	-		

TABLE IV-8 Cont.

AVIAN DENSITIES IN THE FOUR MAJOR HABITAT TYPES DURING THE SUMMER OF 1975 AND 1976

Vegetation Type	Bird (Species)	June 1975 Number Observed	June 1975 Density Per ha	June 1976 Number Observed	June 1976 Density Per ha	June Density Change, % Observed	June Density Change, % Per ha	August 1975 Number Observed	August 1975 Density Per ha	August 1976 Number Observed	August 1976 Density Per ha	August Density Change, % Observed	August Density Change, % Per ha
Riparian (cont.)	Downy Woodpecker	2	-	-	-			1	-	2	-		
	Eastern Kingbird	-	-	1	-			-	-	-	-		
	Western Kingbird	-	-	-				-	-	1	-		
	Ash-throated Flycatcher	4	0.5	4	0.1			-	-	-	-		
	Say's Phoebe	-	-	2	-			1	-	9	0.3	+	
	Willow Flycatcher	-	-	8	0.4	+		-	-	-	-		
	Gray Flycatcher	-	-	1	-			-	-	-	-		
	Western Wood Peewee	6	-	-	-	-		-	-	-	-		
	Violet-Green Swallow	1	-	-	-			4	0.3	-	-		
	Rough-winged Swallow	-	-	-	-			5	0.3	13	0.2	+160	-33
	Cliff Swallow	390	7.6	31	1.2	-92	-84	-	-	14	0.8	+	
	Scrub Jay	-	-	-	-			-	-	1	-		
	Black-billed Magpie	16	0.7	20	0.9	+25	+28	;	-	6	0.4		
	Piñon Jay	-	-	4	-			-	-	8	0.5	+	
	Black-capped Chickadee	6	0.1	4	0.1			-	-	3	-		
	White-breasted Nuthatch	-	-	-	-			-	-	1	-		
	Rock Wren	2	-	9	0.3	+		10	0.3	8	0.4	-20	+33
	American Robin	8	0.3	8	0.1			1	-	6	0.1	-	
	Mountain Bluebird	-	-	2	-			-	-	5	0.1		
	Blue-gray Gnatcatcher	5	0.3	13	1.2	+160	+300	10	0.8	15	0.8	+50	0
	Black-tailed Gnatcatcher	8	0.5	-	-	-		2	-	-	-		
	Cedar Waxwing	1	-	23	1.2	+96		-	-	-	-		
	Starling	10	0.2	8	0.8	-20	+300	-	-	-	-		
	Solitary Vireo	4	-	-	-			-	-	-	-		
	Red-eyed Vireo	1	-	-	-			-	-	-	-		
	Warbling Vireo	2	-	4	0.1			-	-	1	-		
	Orange-crowned Warbler	2	-	-	-			-	-	-	-		
	Virginia's Warbler	12	0.3	-	-	-		-	-	-	-		
	Yellow Warbler	54	1.5	35	1.1	-35	-27	13	1.6	16	0.8	+23	-50
	Yellow-rumped Warbler	1	-	3	0.3			-	-	-	-		
	Black-throated Gray Warbler		-	2	-			3	-	-	-		

TABLE IV-8 Cont.

AVIAN DENSITIES IN THE FOUR MAJOR HABITAT TYPES DURING THE SUMMER OF 1975 AND 1976

Vegetation Type	Bird (Species)	June 1975 Number Observed	June 1975 Density Per ha	June 1976 Number Observed	June 1976 Density Per ha	June Density Change, % Observed	June Density Change, % Per ha	August 1975 Number Observed	August 1975 Density Per ha	August 1976 Number Observed	August 1976 Density Per ha	August Density Change, % Observed	August Density Change, % Per ha
Riparian (cont.)	MacGillivray's Warbler	-	-	1	-			-	-	-	-		
	Common Yellowthroat	1	-	2	-			-	-	-	-		
	Yellow-breasted Chat	13	0.4	11	0.8	-15	+100	3	-	4	-		
	Wilson's Warbler	5	0.3	-	-			-	-	-	-		
	Western Meadowlark	6	-	-	-			-	-	-	-		
	Red-winged Blackbird	-	-	1	-			-	-	-	-		
	Northern Oriole	6	0.1	16	1.1	+167	+	-	-	-	-		
	Brewer's Blackbird	-	-	1	-			-	-	-	-		
	Brown-headed Cowbird	42	0.7	46	3.7	+10	+428	-	-	-	-		
	Western Tanager	7	-	6	-			2	-	1	-		
	Black-headed Grosbeak	8	-	2	-	-75		-	-	-	-		
	Blue Grosbeak	-	-	2	-			-	-	1	-		
	Lazuli Bunting	23	1.2	6	0.3	-74	-75	1	-	-	-		
	House Finch	22	0.4	66	4.0	+200	+900	7	0.5	-	-	-	
	American Goldfinch	-	-	11	1.2	+		-	-	-	-		
	Green-tailed Towhee	-	-	-	-			-	-	2	-		
	Rufous-sided Towhee	41	2.1	35	2.0	-15	-5	23	1.7	13	0.7	-43	-59
	Lark Sparrow	4	0.5	15	1.1	+275	+120	22	0.7	-	-	-	
	Black-throated Sparrow	3	-	-	-			3	-	-	-		
	Sage Sparrow	-	-	-	-			1	-	-	-		
	Chipping Sparrow	5	0.5	-	-	-		-	-	8	0.4	+	
	Brewer's Sparrow	11	1.1	-	-	-		38	3.7	7	0.5	-82	-86
	Total	792	20.6	450	24.2	-43	+18	206	13.6	196	7.9	-5	-42
	Species Total	42		43				26		32			

dusky flycatcher, black-tailed gnatcatcher, red-eyed and solitary vireos, dark-eyed juncos, and Virginia's, orange-crowned, and Wilson's warblers. Present were the great blue heron, green-winged teal, ring-necked pheasant, bushtit, mockingbird, hermit thrush, Scott's oriole, rose-breasted and blue grosbeaks, and gray-headed junco (Table IV-7).

Birds seen on transects totaled about 900, a 36% decrease from 1975. As in last June, half the total were in the riparian habitat. Population densities (number/ha) decreased in greasewood and shadscale but remained about the same in riparian and juniper (Table IV-8). Twenty-eight species were observed in shadscale, the same as in 1975. Only 28 species used the juniper habitat, a decline of 8 from 1975. The greasewood habitat supported 36 species, a decline of 12. The riparian habitat supported 62 species, a decline of 6 from 1975. The number of cliff swallows observed along the river declined from 390 (7.6/ha) in 1975 to 31 (1.2/ha) this year. The number of yellow warblers and lazuli buntings seen also declined.

As usual, August was hot and dry, with thunderstorms. There were few flowers, some perennial shrubs were beginning to bloom, and the insect fauna had changed considerably. For reasons as yet unknown, many of the birds leave the area sometime during July: An average of 40% of the individuals and 30% of the species seen in June were gone by August for the two years of monitoring. The decrease was more radical in 1975 (48% of the individuals, 36% of the species) then in 1976 (33% and 25%, respectively). During August 1975 and 1976 population densities increased in greasewood and declined in the other three habitats (Table IV-8).

The past two summers indicate how birds use their mobility to respond immediately to changes in their environment. In 1975 conditions were good and the birds stayed on the tracts; in 1976 the birds responded to adverse conditions by leaving.

Mammals

Whereas conditions on the tracts in 1976 were adverse for birds, they were good for mammals: 39 mammal species occupied the tracts this summer, as opposed to 23 in summer 1975. Additional species identified this year were 12 species of bats and 2 rock squirrels this summer (Table IV-9). Of the 50 bats captured in mist nets, the most numerous were the little brown bat (*Myotis lucifugus*) and the western pipistrel (*Pipistrellus hesperus*). The number of bats seen on evening transects also increased this August (Table IV-10).

TABLE IV-9

MAMMALIAN SPECIES LIST, DISTRIBUTION, AND STATUS ON OR WITHIN 1.6 KM (1 mi) OF UTAH OIL SHALE TRACTS, JUNE AND AUGUST, 1976

x = mammal observed, G = greasewood, J = juniper, S = shadscale, R = riparian
p = permanent resident, year round occurrence, s = summer resident, nests in area, migrates during winter
t = transient, passes through area

Mammal (Order/Species)	June 1976 Vegetation Type G	J	S	R	August 1976 Vegetation Type G	J	S	R	Status
Chiroptera									
Little Brown Myotis	x	-	-	-	x	-	-	-	s
Yuma Myotis	-	-	x	-	x	-	-	-	s
Long-eared Myotis	x	-	-	-	x	-	-	-	s
Long-legged Myotis	-	-	-	-	x	-	-	-	s
California Myotis	?	-	?	-	x	-	x	-	s
Small-footed Myotis	?	-	-	-	x	-	-	-	s
Silver-haired Bat	x	-	-	-	-	-	-	-	s
Western Pipistrel	-	-	-	-	x	-	x	-	s
Big Brown Bat	x	-	-	-	-	-	-	-	s
Hoary Bat	-	-	-	-	x	-	-	-	s
Western Big-eared Bat	x	-	-	-	-	-	-	-	s
Pallid Bat	x	-	-	-	x	-	-	-	s
Carnivora									
Raccoon	-	-	-	?	-	-	-	-	
Skunk (striped)	-	-	-	-	-	-	-	?	
Badger	-	-	x	-	-	-	-	-	p
Coyote	x	x	-	-	x	x	x	-	p
Rodentia									
Whitetail Prairie Dog	-	-	x	-	-	-	x	x	p
Rock Squirrel	-	-	-	-	x	-	-	-	
Golden-mantled Squirrel	x	x	x	x	x	x	-	x	p
Whitetail Antelope Squirrel	x	x	x	x	x	x	x	-	p
Least Chipmunk	?	x	?	?	-	x	-	x	p
Apache Pocket Mouse	x	x	x	x	x	x	x	x	p
Ord Kangaroo Rat	x	-	x	x	x	-	x	x	p
Beaver	-	-	-	x	-	-	-	x	p
Western Harvest Mouse	x	-	-	-	x	x	x	x	p
Cañon Mouse	-	x	-	-	-	x	-	-	p
Deer Mouse	x	x	x	x	x	x	x	x	p
Brush Mouse	-	-	-	-	-	-	x	x	p
Piñon Mouse	-	x	-	-	x	x	-	-	p
Desert Woodrat	x	x	x	x	x	x	x	x	p
Bushytail Woodrat	-	-	-	x	-	x	-	x	p
Muskrat	-	-	-	x	-	-	-	-	p
Porcupine	-	-	-	x	-	-	-	x	p
Lagomorpha									
Blacktail Jackrabbit	-	-	-	-	-	-	x	-	?
Desert Cottontail	x	x	x	x	x	x	x	x	p
Artiodactyla									
Mule Deer	x	x	x	x	x	x	x	x	p
Domestic Sheep	-	-	x	x	-	-	-	x	p
Domestic Cattle	-	-	x	x	-	-	x	x	s
Domestic Horse	-	-	-	-	-	-	-	x	s

TABLE IV-10

MAMMAL DENSITIES IN THE FOUR MAJOR HABITAT TYPES DURING THE SUMMER OF 1975 AND 1976

		June						August					
		1975		1976		Density Change, %		1975		1976		Density Change, %	
		Density						Density					
		Number		Number				Number		Number			
Vegetation Type	Mammal (Species)	Observed	Per ha	Observed	Per ha	Observed	Per ha	Observed	Per ha	Observed	Per ha	Observed	Per ha
Greasewood	Bat	1	-	-	-	-45	-20	7	0.5	6	0.6	-14	+20
	Golden-mantled Squirrel	2	-	1	-			1	-	-	-		
	Whitetail Antelope Squirrel	20	0.5	11	0.4	-45	-20	-	-	2	-		
	Chipmunk (Least)	-	-	1	-			1	-	-	-		
	Desert Cottontail	6	0.1	66	2.1	+1000	+2000	15	0.6	96	4.5	+540	+650
	Mule Deer	-	-	-	-			-	-	4	-		
	Total	29	0.6	79	2.5	+172	+317	24	1.1	108	5.1	+350	+364
	Species Total	4		4				4		4			
Juniper	Bat	-	-	-	-			1	-	-	-		
	Golden-mantled Squirrel	5	-.1	-	-	-	-	-	-	-	-		
	Chipmunk (Least)	1	-	-	-			1	-	1	-		
	Desert Woodrat	-	-	-	-			2	-	-	-		
	Desert Cottontail	4	0.2	20	1.1	+350	+450	12	0.6	69	2.3	+475	+283
	Mule Deer	1	-	-	-			-	-	-	-		
	Total	11	0.3	20	1.1	+82	+267	16	0.6	70	2.3	+338	+283
	Species Total	4		1				4		2			

TABLE IV-10 Cont.

MAMMAL DENSITIES IN THE FOUR MAJOR HABITAT TYPES DURING THE SUMMER OF 1975 AND 1976

Vegetation Type	Mammal (Species)	June 1975 Density Number Observed	June 1975 Density Number Per ha	June 1976 Density Number Observed	June 1976 Density Number Per ha	June Density Change, % Observed	June Density Change, % Per ha	August 1975 Density Number Observed	August 1975 Density Number Per ha	August 1976 Density Number Observed	August 1976 Density Number Per ha	August Density Change, % Observed	August Density Change, % Per ha
Shadscale	Bat	-	-	-	-			-	-	1	-		
	Whitetail Antelope Squirrel	1	-					2	-	8	0.3	+	
	Desert Woodrat	-	-	-	-			-	-	3	0.3		
	Desert Cottontail	16	0.1	33	2.1	+106	+2000	18	0.2	47	2.4	+161	+1100
	Total	17	0.1	33	2.1	+94	+2000	20	0.2	59	3.0	+195	+1400
	Species Total	2		1				2		4			
Riparian	Bat	4	-	-	-			8	0.9	38	2.4	+375	+167
	Golden-mantled Squirrel	1	-	-	-			1	-	-	-		
	Whitetail Antelope Squirrel	-	-	1	-			-	-	-	-		
	Chipmunk (Least)	1	-	-	-			-	-	-	-		
	Beaver	1	-	3	-			1	-	5	-		
	Desert Woodrat	-	-	-	-			-	-	1	-		
	Porcupine	1	-	-	-			-	-	1	-		
	Desert Cottontail	14	0.7	31	2.4	+121	+245	6	0.1	81	6.1	+1250	+6000
	Mule Deer	1	-	-	-			6	-	5	0.4		
	Domestic Cattle	-	-	-	-			33	2.1	31	0.4	-6	-81
	Total	16	0.7	35	2.4	+119	+243	55	3.1	162	9.3	+194	+343
	Species Total	7		3				6		7			

The population densities of many mammals, especially rodents and rabbits, increased in 1976. A blacktail jackrabbit (Lepus californicus) was observed south of the White River, as were whitetail prairie dogs (Cynomys gunnisoni), which have always been seen only around their town in the northeast corner of the project area. Mule deer (Odocoileus heminous), seldom seen in 1975, were commonly seen this year.

The number of desert cottontails (Sylvilagus auduboni) observed on the transects in June 1976 doubled from last year in the shadscale and riparian habitats, increased by fivefold in the juniper habitat, and by tenfold in the greasewood habitat. Comparing August 1975 with August 1976, the number of cottontails tripled in shadscale, increased by sixfold in juniper and greasewood, and by twelvefold in the riparian habitat (Table IV-10).

The number of nocturnal rodents also increased in 1976. Three trap grids of 144 traps each and one trap grid of 72 traps in the riparian area were set and checked for 5 nights. Population densities, calculated by dividing the number of individuals captured by the area of the grid, increased by 55% in greasewood, 93% in juniper, 158% in shadscale, and 250% along the White River (Table IV-11). Western harvest mice (Reithrodontomys megalotis), usually captured only in greasewood, were found in all habitats this August. The number of bushytail woodrats (Neotoma cincerea), the largest mammal captured except for some cottontails, increased from zero in 1975 to eight individuals this year in the juniper. In the juniper habitat, which supports the lowest density and the highest diversity of rodents, the number of least chipmunks (Eutamias minimus), pinyon mice (Peromyscus truei), canyon mice (P. crinitus), and deer mice (P. maniculatus) increased. Deer mice, the most abundant mammal on the tracts in 1975, increased in population density by 55% in juniper, 124% in greasewood, and more than 300% in the shadscale and riparian habitats. In 1975 rodent populations were densest in greasewood, less dense in shadscale and juniper, and least dense in the riparian area. In 1976, the lowest densities were in juniper and riparian areas.

Reptiles and Amphibians

Fifteen species of reptiles and amphibians were found on the tracts this summer (Table IV-12). The four amphibians were observed along the White River, and none were found in Evacuation Creek, probably because of the creek's chemical and physical characteristics. In June 1976 frogs and toads were far more vocal than in June 1975.

TABLE IV-11

RODENT DENSITY AND DISTANCE MOVED FROM TRAP TO TRAP IN A 12 x 12 TRAP GRID IN THE FOUR MAJOR VEGETATION TYPES

Trap stations = 144; Area - 3.24 hectares, except the riparian - 1.62 hectares

Vegetation Type	Rodent (Species)	1975 Density Number Individual	1975 Density Number per/ha	1975 Sex Ratio, M/F	1976 Density Number Individual	1976 Density Number per/ha	1976 Sex Ratio, M/F	Density Change, %
Greasewood	Whitetail Antelope Squirrel	10	3	1/2.3	17	5	1/1.4	+68
	Least Chipmunk	1	<1	0/1	1	<1	-	
	Apache Pocket Mouse	19	6	1/1.7	17	5	1/1.8	-11
	Ord Kangaroo Rat	16	5	1/ .4	14	4	1/ .4	-12
	Western Harvest Mouse	-	-	-	5	2	1/ .7	+
	Deer Mouse	25	8	1/ .7	56	17	1/1.1	+124
	Piñon Mouse	-	-	-	2	<1	1/1	
	Desert Woodrat	2	<1	2/0	5	2	1/ .7	+
	(Desert Cottontail)	(2)			(1)			
	Total Rodents	73	22		113	35		+55
	Species Total	6			8			
Juniper	Golden-mantled Squirrel	-	-	-	1	<1	0/1	
	Whitetail Antelope Squirrel	2	<1	1/1	1	<1	1/0	
	Least Chipmunk	2	<1	1/1	9	3	1/ .1	+350
	Apache Pocket Mouse	7	2	1/6	3	<1	0/3	-58
	Western Harvest Mouse	-	-	-	1	<1	0/1	
	Cañon Mouse	4	1	1/1	8	2	1/ .6	+100

TABLE IV-11 (Cont.)

RODENT DENSITY AND DISTANCE MOVED FROM TRAP TO TRAP IN A 12 x 12 TRAP GRID IN THE FOUR MAJOR VEGETATION TYPES

Trap stations = 144; Area - 3.24 hectares, except the riparian - 1.62 hectares

Vegetation Type	Rodent (Species)	1975 Density Number Individual	1975 Density Number per/ha	1975 Sex Ratio, M/F	1976 Density Number Individual	1976 Density Number per/ha	1976 Sex Ratio, M/F	Density Change, %
Juniper (cont.)	Deer Mouse	13	4	1/ .8	24	7	1/ .8	+80
	Piñon Mouse	-	-	-	13	4	1/1.6	+
	Desert Woodrat	18	6	1/1.2	21	6	1/1.1	+16
	Bushytail Woodrat	-	-	-	8	2	1/1	+
	(Desert Cottontail)	(1)			(3)			
	Total Rodents	46	14		89	27		+93
	Species Total	6			10			
Shadscale	Golden-mantled Squirrel	1	<1	-	-	-	-	
	Whitetail Antelope Squirrel	16	5	1/ .8	18	6	1/1.2	+12
	Apache Pocket Mouse	6	2	1/1	8	2	1/ .6	+36
	Ord Kangaroo Rat	7	2	1/ .5	9	3	1/ .3	+27
	Western Harvest Mouse	-	-	-	3	<1	1/2	
	Deer Mouse	19	6	1/ .7	83	26	1/1.1	+335
	Brush Mouse	1	<1	-	1	<1	1/0	
	Desert Woodrat	1	<1	1/0	7	2	1/ .4	+600
	(Desert Cottontail)	(0)			(1)			
	Total Rodents	50	15		129	40		+158
	Species Total	7			7			

TABLE IV-11 (Cont.)

RODENT DENSITY AND DISTANCE MOVED FROM TRAP TO TRAP IN A 12 x 12 TRAP GRID IN THE FOUR MAJOR VEGETATION TYPES

Trap stations = 144; Area - 3.24 hectares, except the riparian - 1.62 hectares

Vegetation Type	Rodent (Species)	1975 Density Number Individual	1975 per/ha	1975 Sex Ratio, M/F	1976 Density Number Individual	1976 per/ha	1976 Sex Ratio, M/F	Density Change, %
Riparian	Least Chipmunk	-	-	-	1	<1	0.1	
	Apache Pocket Mouse	1	<1		-	-	-	
	Western Harvest Mouse	-	-	-	3	2	1/2	+
	Deer Mouse	8	5		33	20	1/ .6	+314
	Brush Mouse	-	-	-	1	<1	0/1	
	Desert Woodrat	1	<1		-	-	-	
	Bushytail Woodrat	2	1		4	2	1/1	+50
	Total Rodents	12	7		42	26		+250
	Species Total	4			5			

TABLE IV-12

REPTILE AND AMPHIBIAN SPECIES LIST FROM OBSERVATIONS ON OR WITHIN 1.6 KM (1 mi) OF UTAH OIL SHALE TRACTS, JUNE AND AUGUST, 1976

x = observation, G = greasewood, J = juniper, S = shadscale, R = riparian

	Date							
	June 1976				August 1976			
	Vegetation Type				Vegetation Type			
Reptile and Amphibian (Order/Species)	G	J	S	R	G	J	S	R
Salientia								
Great Basin Spadefoot Toad	-	-	-	x	-	-	-	-
Woodhouse's Toad (Subspii woodhousei)	-	-	-	x	-	-	-	x
Chorus Frog (Subspii triseriata)	-	-	-	x	-	-	-	-
Leopard Frog	-	-	-	x	-	-	-	x
Squamata								
Eastern Fence Lizard (Subspii elongatus)	x	x	x	x	-	x	-	x
Sagebrush Lizard (Subspii graciosus)	x	x	x	x	x	x	x	x
Side-blotched Lizard (Subspii stansburiana)	x	x	x	x	x	x	x	x
Tree Lizard	-	x	-	x	-	x	-	x
Short-horned Lizard	x	-	x	-	x	-	x	-
Western Whiptail	x	x	x	x	x	x	-	x
Racer (Subspii mormon)	-	-	-	x	-	-	-	-
Striped Whipsnake (Subspii taehniatus)	x	-	x	-	x	-	-	x
Gopher Snake (Subspii deserticola)	x	x	x	x	x	x	x	-
Western Rattlesnake (Subspii concolor)	x	x	-	x	x	x	-	-
Western Terrestrial Garter Snake (Subspii vagrans)	-	-	-	-	-	-	-	x

Eastern fence lizards and tree lizards were usually found in the juniper and riparian habitats, most often in the river bottom. A few fence lizards were also found in greasewood. Both species prefer vertical perches provided by rock faces and trees.

Sagebrush, side-blotched, and short-horned lizards are found in open, horizontal places. Sagebrush lizards were found predominantly in sagebrush. Side-blotched lizards were found on sandstone outcrops and in juniper, with its sparse ground vegetation; short-horned lizards were found in the bare areas of shadscale and greasewood, often around ant hills; and western whiptails, the fastest lizard on the tracts, were found in greasewood. The most common snake on the tracts was the gopher snake. Found in all habitats, it often waits atop or beside the rodent traps. The racer, the least docile of the snakes, and the western terrestrial garter snake, the most docile, were found only in the White River bottomlands. The striped whipsnake was seldom seen in shadscale. The western rattlesnake, appropriately called the midget-faded rattlesnake, was found throughout the tracts, except along the White River.

The estimates of reptile population densities from transect walks are weak because of reptile behavior and partially because of method. Lizards adjust their schedule month to month, day to day, and hour to hour. Different species have different thermal preferences, activity periods, foraging strategies, and tolerance to wind and rain. Sampling at the same time every day during changing weather does not take these specific behaviors and responses into account.

b. <u>Mule Deer</u>

The activities of the two does monitored through the summer centered around the same areas in which they spent the summer and fall 1975. Deer .09 stayed around the mouth of Asphalt Wash on the White River and occasionally ventured into the uplands along the river. Deer .06 stayed along the riparian area at the Evacuation Creek slurry-pipeline crossing of the White River. Both deer were also monitored at night. Except for an approximately 2-hr period in which deer .09 could not be located, both deer remained around their accustomed areas of use during the night.

Both deer had fawns with them during this quarter. Deer .09 was accompanied by twin fawns and deer .06 had a single fawn, although in the dense cover a second fawn could easily have been missed.

Deer .17, a yearling buck, was monitored during the summer. No tendency to center activities around a definite area could be observed. Sightings were made in several different habitats, including upland types. It seems evident from the data from the three males monitored since 1975 that they are more mobile, possibly because of freedom from the demands of nursing and caring for fawns. None have set up the distinct patterns of preferred-use areas so evident with does.

In addition to the radio monitoring, random visual sightings of deer were also recorded. Although these types of data are subjective, there was a definite impression of more deer in the project area than in 1975. This was also confirmed in discussions with other field biologists working in this area. This abundance is natural considering the excellent fawn production and buck-only harvest in 1975.

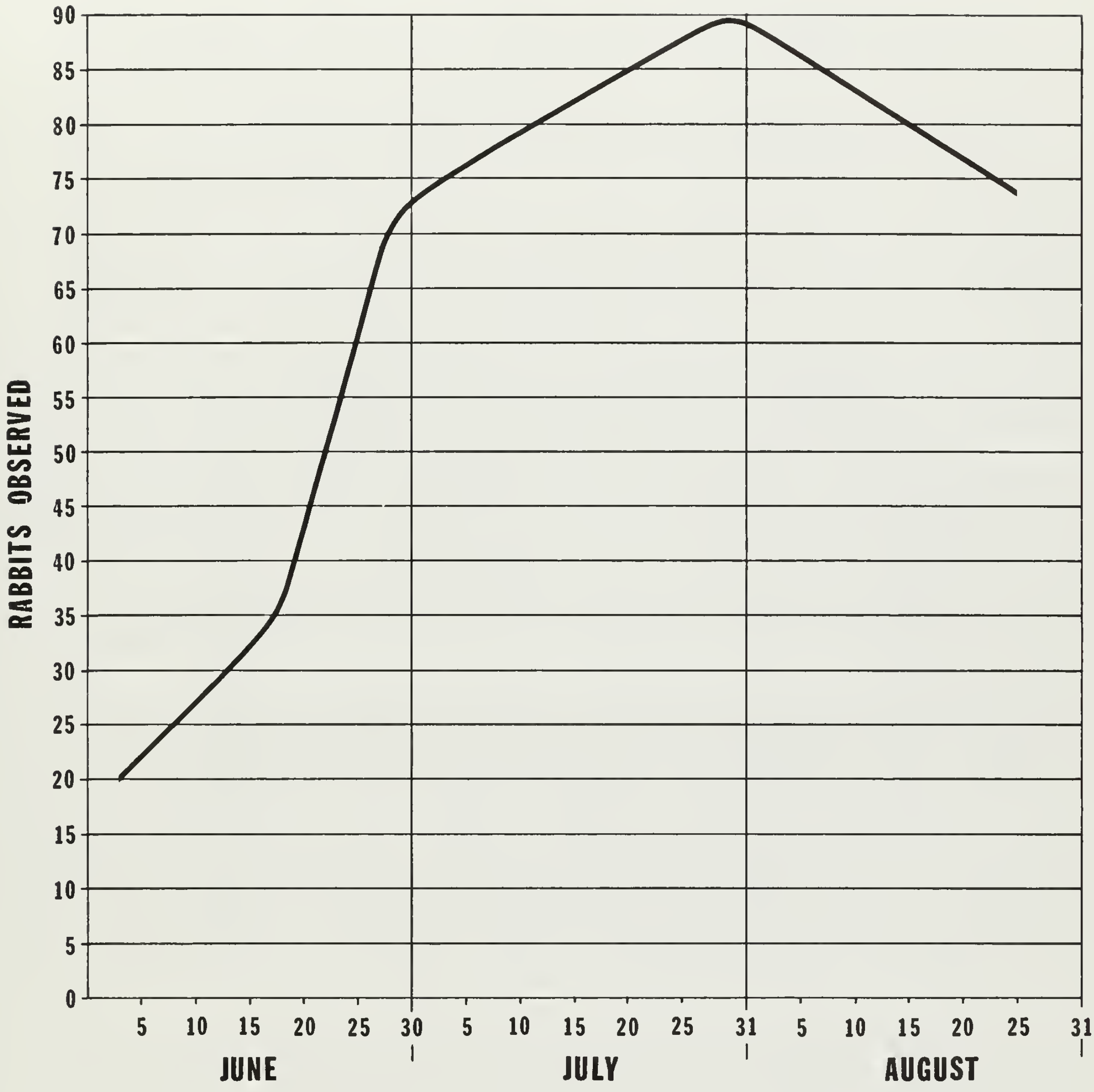
c. Canada Geese

The July 29 census indicated that all geese had left the river by this date. A subsequent survey August 15 in which no geese were present confirmed this. At peak population levels in 1976 birds and goslings were more numerous than in 1975, probably as a result of recruitment of geese hatched on the White River into the breeding population. With adequate habitat available for nesting and gosling production, recruitment may continue to add breeding birds to the population. Follow-up survey work over a period of several years will be necessary to ascertain breeding success.

d. Cottontail Rabbits

As indicated on Figure IV-2, the number of cottontails observed increased dramatically until a peak was reached July 29. At this point, 90 rabbits, or 7.2 rabbits/km (4.5 rabbits/mi), were observed, an increase of 450% over the June 3 count of 20 rabbits, or 1.6 rabbits/km (1.0 rabbits/mi). This rapid increase is attributed to the increased recruitment of young rabbits into the population. Similar trends are evident in field data from other areas in northeastern Utah, indicating that cottontails are in a phase of increase in their population cycle (Table IV-13).

Several facts about cottontail rabbit populations are evident from the data available:



COTTONTAIL RABBIT ROADSIDE COUNTS

FIGURE IV-2

TABLE IV-13

RABBITS OBSERVED/MILE

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	10 Year Average
Daggett	1.93	.81	.60	.77	.76	.73	.50	.24	.24	.67	.73
Duchesne	1.40	.77	.68	.56	.58	.24	.14	.29	.67	1.00	.63
Uintah	1.00	.98	.84	1.56	1.39	.97	.14	.19	.32	1.35	.87
Regional	1.30	.82	.68	.93	.89	.60	.26	.24	.43	.98	.71
Statewide	.35	.41	.32	.50	.44	.43	.18	.29	.22	*	.36
Project Area										4.5	

* Unavailable at this time - 9 Year Average

1) Cottontail rabbits statewide, region-wide (Daggett, Duchesne, and Uintah counties), and on the project area have increased dramatically from cyclic lows in 1973.

2) Rabbit populations in the three-county region in 1976 are above the ten-year average and are higher than in any single year since 1967.

3) The ten-year average of rabbits per mile in the region is approximately double that for the state as a whole and for any other region of the state.

4) The number of rabbits per mile on the project area in 1976 is 450% greater than the regional average for 1976, exclusive of project-area data.

5) The number of rabbits per mile on the project area is more than double (4.5 versus 1.93) the highest level recorded on any route in Utah during the last ten years.

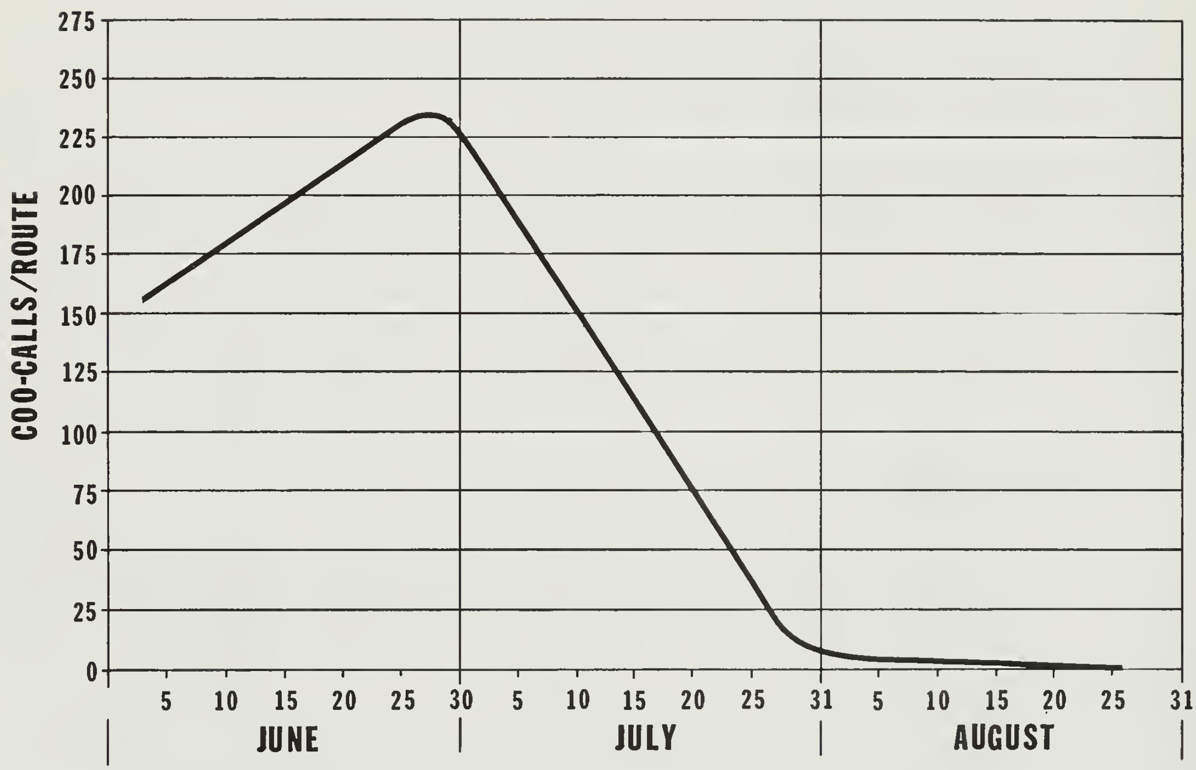
It is reasonable to propose that the project area contains some of the most suitable cottontail habitat to be found within Utah.

e. Mourning Doves

In 1976 the peak number of calls was heard on June 28 (Figure IV-3), indicating that although doves frequently bring off two or more clutches of eggs during a breeding season, the peak of breeding birds occurs early in summer. However, although this peak is reached gradually as the number of breeding birds increases during late May and June, one month after this peak breeding activity has almost ceased. This period from mid-May until the end of June, then, appears to be critical to mourning doves breeding in the project area.

At the peak of breeding on June 28, 31 doves were heard calling, which is a density of 1.55 per station (20 stations). Data for the state of Utah indicates a ten-year statewide average of 15.7 calling birds per route, or .79 per station. Much variability is inherent in these figures because of varying weather and conditions from area to area and year to year. Also, statewide routes are run in late May, and the project-area data indicate that the breeding peak is in late June.

As a further comparison of project area data, information gathered from a Division of Wildlife Resources route from



MOURNING DOVE COO-CALL PER ROUTE

FIGURE IV-3

Deadman Bench, 8 km (5 mi) north of Bonanza along Utah 45 to the mouth of Dragon Canyon to the south, is available. This route has averaged 23.7 doves per route, or 1.19 per station, well above the state average. The 1976 route yielded 27 doves heard on May 28, 1976, as compared with 25 doves heard on June 3, 1976, on the project-area route. It may be assumed that because of the geographical proximity, habitat similarities, and agreement in 1976 breeding indices there should be good correlation between the two routes. From these data, then, the following is assumed:

1) The project area supports a relatively high population of breeding mourning doves, compared with the state average.

2) Breeding populations are slightly higher than the ten-year average for this area and considerably higher than the 1975 index of seven doves heard (see Table IV-14).

f. Pellet-Group Transects

Tables IV-15 and IV-16 summarize pellet-group counts in deer days use per acre, as determined from 1976 transects. Figure IV-4 locates these pellet-group transects. Table IV-17 lists use according to vegetative type. In calculating utilization in deer days use per acre, the following specifications and conversion factors apply, as illustrated in the sample computation:

PELLET GROUP COUNT

Size Plots 1/100 acre

No. Plots 25

No. Pellet Groups 3

*Comp. Factor x No. Pellet Groups = Deer Days Use/Acre

1.34 x 3 = 4.02

Deer Days Use/Acre 4

Remarks Transect G-18 Riparian

Table for use only with 100 sq. ft. size plots:

No. Plots	Comp. Factor
25	1.34
50	.67
60	.558
70	.48
80	.42
100	.335
120	.279
140	.239
150	.223
200	.167
250	.134
300	.111
400	.084
500	.067
1,000	.034

*Computation Factor has been computed so that this factor multiplied by number of pellet groups will give deer days use/acre. Use the Comp. Factor corresponding to the number of plots taken.

TABLE IV-14

MOURNING DOVE COO-CALL ROUTES, DEADMAN TO DRAGON AND STATEWIDE AVERAGE
1966 THROUGH 1976

ROUTE	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	10 Year Average
Deadman - Dragon		17	33	38	15	66	4	18	12	7	27	23.7
Statewide Average	13.5	19.7	15.2	14.3	13.4	22.7	14.3	12.8	19.3	12.1	*	15.7

*unavailable at this time

TABLE IV-15

SWEPT PELLET TRANSECTS, MULE DEER

Location	Type	No. Plots	DDU/Ac.*
Evacuation Creek	Riparian	50	6
G-18	Riparian	25	4
X-2	Riparian	25	2
PP-12	Riparian	25	1
X-5	Juniper-sage	50	3
X-10	Juniper-sage	25	1
PP-10	Juniper-sage	50	0
PP-17	Greasewood-sage	50	0
X-11	Greasewood-sage	50	0
PP-4	Greasewood-sage	25	0
PP-5	Sage-shadscale	50	0
PP-19	Sage-shadscale	50	2
P-4	Sage-shadscale	25	0

*Deer Days Use Per Acre.

TABLE IV-16

RANDOM TRANSECTS, MULE DEER

Location	Vegetative Type	DDU/Ac.*
F-5	Riparian	2
F-2	Riparian	5
F-4	Riparian	4
Ignacio Highlands	Juniper-sage	4
P-3	Juniper-sage	2
PP-7	Juniper-sage	1
PP-3	Greasewood-sage	0
G-2	Greasewood-sage	0
G-15	Greasewood-sage	0
X-6	Shadscale-sage	0
X-4	Shadscale-sage	1
HS-4	Shadscale-sage	0

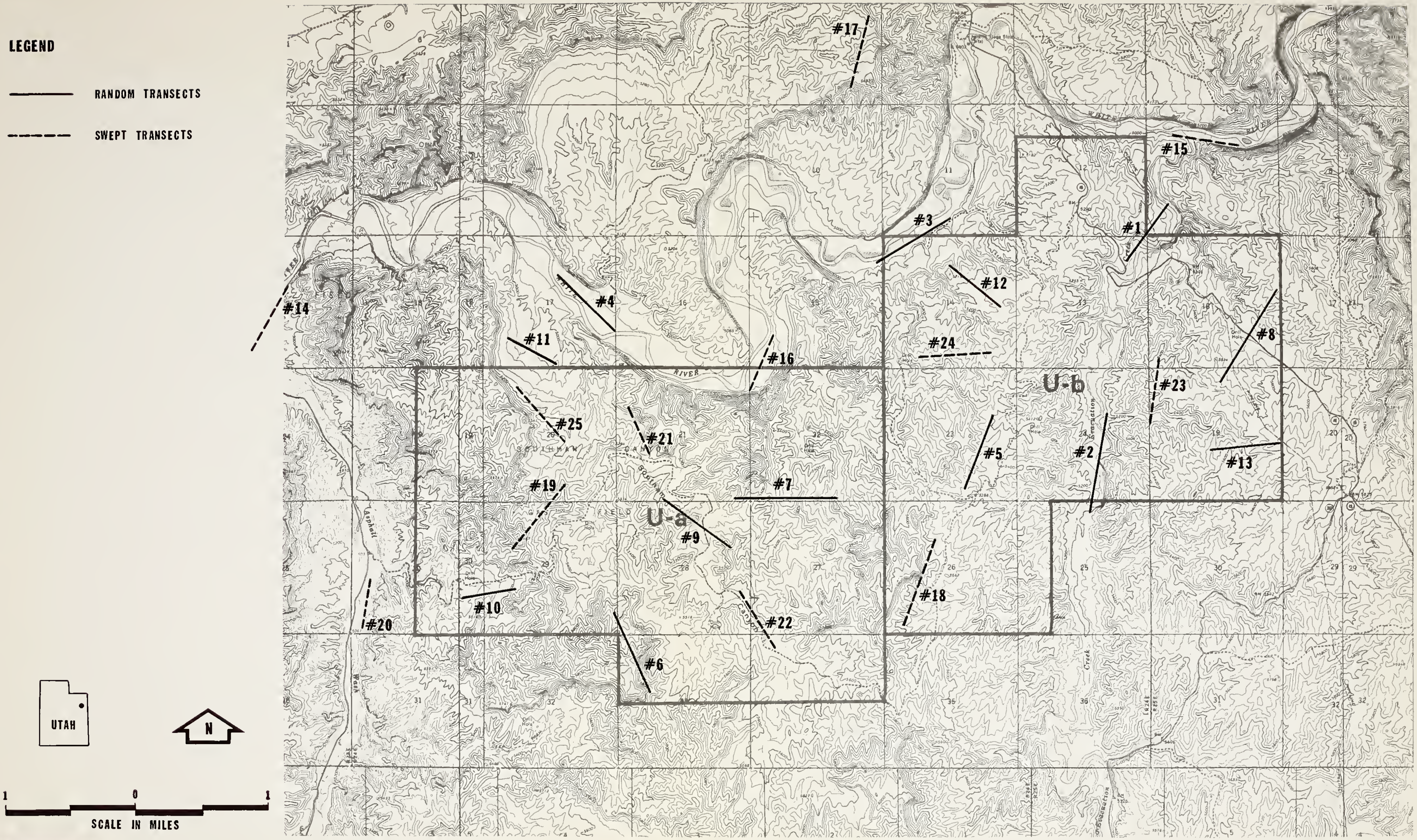
*Deer Days Use Per Acre.

TABLE IV-17

DEER UTILIZATION BY VEGETATIVE TYPE

Vegetative Type	No. Transects	No. Plots	DDU/Ac.*
Riparian	7	425	3.7
Juniper - Sage	6	425	2.1
Greasewood - Sage	6	425	0
Shadscale - Sage	6	425	0.5

*Deer Days Use Per Acre.



RANDOM AND SWEPT PELLET TRANSECTS

FIGURE IV-4

The computed figure is expressed in deer days use per acre, or the equivalent of one deer spending one day on an acre plot of ground.

Several sources of error are inherent in analyzing data derived from pellet-group transects. For instance, pellet groups can be missed, especially in the riparian areas, where a rank growth of Bromus creates a dense mat, concealing pellet groups.

Errors can also be made in separating sheep pellets from deer pellets. Many pellet groups are readily distinguishable as either deer or sheep, but a third segment falls into an unclassified category. For the purposes of this study, all groups were categorized as either sheep or deer based on a rather subjective observer analysis of known concentrations of sheep and deer using the area; however, it is felt that some error still exists in this overlapping of pellet morphology.

Another kind of error is especially likely in the more xeric areas of the tracts, where pellet groups on unprotected ground can be washed away by the heavy intermittent rains characteristic of the area. Many pellets are washed away or dispersed so that the integrity of the group is lost. In such cases, a subjective observer estimate was made.

Another kind of error can be made in estimating the age of pellet groups. In standard transect methods, the pellet groups of the previous year are counted. This is facilitated by the migratory patterns of deer, which make it easy to discern winter and summer ranges and a definite age gap in pellet groups in either area. However, on the project area, some deer use is evident in all vegetative types during practically all times of the year; consequently, a gradient of pellet-group ages is present. For this study, groups that appeared to be from the previous winter (1975-76) were counted in the juniper/sage and from the immediately preceding spring (1976), in the riparian type. Deer use in the other two vegetative types is too low to be reliable in assessing use per acre.

The riparian vegetative type was found to be the most heavily used on the project area, followed closely by the juniper/sage area. This is consistent with previous field observations, which indicated that deer selectively use these areas in summer and winter. The other two types--shadscale/sage and greasewood/sage--indicated very low levels of use by deer, although browse use from these types is in many areas moderate to heavy. Use, then, was attributed almost entirely to sheep in these two types.

g. Amphibians and Reptiles

Amphibians

Amphibians on the two tracts are found only in the riparian vegetation along the White River and are active from May through September. No amphibians have been found at gas-well water ponds south of Tract U-a or in Asphalt Wash or Evacuation Creek during flow events. Since the landform of the tracts precludes extensive pool formation during summer thundershowers, the absence of amphibians outside the riparian community is not surprising.

Four amphibian species have been observed along the White River in 1976. The leopard frog (*Rana pipiens*) is the most common species. During summer 1976 leopard frogs were observed in a single basin directly west of Ignacio Stage Stop near the Bonanza pump station. In June the basin contained four adult leopard frogs, several thousand leopard frog tadpoles, several Great Basin spadefoot toads (*Scaphiopus intermontanus*), several Woodhouse toads (*Bufo woodhousei*), a chorus frog (*Pseudacris triseriata*), and many aquatic invertebrates. By August the pool was dry, and only a few adult and many juvenile frogs were present. Spadefoot toad tadpoles were not present; it was assumed they metamorphosed and left the area.

Lizards

Reptiles, seen in all four vegetation communities in the project area, were active during the quarter. The maximum number of animals sighted during June, July, and August 1975 are shown on Table IV-18. The number of recaptures was too small to make reliable population estimates.

Snakes

Snakes were seen in all four vegetation communities of the White River. Observations were made by diurnal and nocturnal road runs in June, July, and August 1976.

Seven species of snakes probably inhabit the area. As of August 1976, five species have been observed within the 1.6-km (1-mi) perimeter around the lease tracts. The plateau night snake (*Hypsiglena torquata*), possibly the rarest ser-

TOTAL NUMBER OF LIZARDS OBSERVED IN EACH VEGETATION PLOT
AND
SPECIES DIVERSITY*

Species	Common Name	Riparian	Sagebrush-Greasewood	Shadscale	Juniper	Totals
Sceloporous undulatus elongatus	Northern Plateau Lizard	11	1	1	1	14
Sceloporous graciosus graciosus	Northern Sagebrush	0	1	13	7	21
Uta stansburiana stansburiana	Northern Side-blotched Lizard	2	3	6	7	18
Phrynosoma douglassi	Short-horned Lizard	0	0	1	0	1
Cnedmidophorous tigris	Western Whiptail	2	4	3	2	11
Urosaurus ornatus	Tree Lizard	5	0	0	1	6
Totals		20	9	24	18	71
Shannon-Wiener Diversity Index		1.64	1.75	1.74	1.88	2.29

*Numbers represent either the number of marked animals or the greatest number of observations made during one day, whichever is greater.

pentine inhabitant of the region, and the milk snake (Lampropeltis triangulum taylori) probably inhabit the site, but have not been observed there. All verified snake observations through October 1976 will be presented in the Final Environmental Baseline Report.

Preliminary observations from analysis of second-year data include the following:

(1) The three lizard species found in all four vegetation communities were the northern side-blotched lizard (Uta stansburiana stansburiana), the northern plateau lizard (Sceloporous undulatus elongatus), and the western whiptail (Cnemidophorous tigris tigris).

(2) The northern sagebrush lizard (Sceloporous graciosus graciosus) was the most abundant lizard on the plots.

(3) The most abundant lizard within a vegetation type was the northern sagebrush lizard in the shadscale community.

(4) Northern plateau lizards and tree lizards (Urosaurus ornatus) inhabited standing and fallen cottonwood trees in the riparian community.

(5) Outside the riparian community the tree lizard was found only once in the juniper plot.

(6) The distribution of the short-horned lizard (Phrynosoma douglassi) appeared to be restricted to the shadscale community.

(7) The western whiptail (Cnemidophorous tigris), the largest lizard in the area, was seen primarily in the sagebrush-greasewood community and to a lesser extent, in the juniper and shadscale communities. The whiptails observed on the riparian plot were near or in greasewood.

(8) It was assumed from visual inspection that the lizard assemblage in any one of these vegetation communities was significantly different from that of any other.

(9) The application of the Shannon-Wiener Diversity Index to the data indicated increasing species diversity in the order juniper, sagebrush-greasewood, shadscale, and riparian.

(10) The results of the lizard-population study are presented on Table IV-19. In computing the final population estimates, consideration was given to the decreasing number of marked animals observed through time as a result of shedding and differences in sampling times from month to month.

TABLE IV-19

1976 LIZARD POPULATIONS

Habitat/Species	Precensus Marked Lizards	Census Period June Marked	Census Period June Unmarked	Population Estimate	Census Period July Marked	Census Period July Unmarked	Population Estimate	Census Period August Marked	Census Period August Unmarked	Final Population Estimate*
Sage/Greasewood										
Northern Side-Blotched	3	1	2	9	0	2	≥9	0	3	9
Northern Plateau	0	0	1	≥1	0	0	0	0	1	1
Western Whiptail	3	0	10	≥33	0	4	≥15	0	1	30-35
Northern Sagebrush	0	0	0	0	0	1	≥1			2-3
Juniper										
Northern Side-Blotched	14	3	12	70	0	6	≥98	0	14	70
Northern Plateau	1	0	2	≥3	0	3	≥4	0	2	3-5
Western Whiptail	1	0	5	≥6	0	2	≥3	0	4	6-8
Northern Sagebrush	7	2	5	24.5	2	8	35	0	4	25
Tree	0	0	1	≥1	0	0	0	0	0	1-3
Shadscale										
Northern Side-Blotched	6	7	6	11.1	0	5	≥6	0	5	11
Western Whiptail	3	0	7	≥24	0	1	≥6	0	0	20-30
Northern Sagebrush	13	9	24	47.7	5	22	70.2	0	12	50
Mountain Short-horned	1	0	0	≥1	0	0	0	0	0	1-3
Northern Plateau Lizard	0	0	0	0	0	0	0	0	1	1-3
Riparian										
Northern Side-Blotched	0	0	3	≥3	0	0	0	0	0	5-8
Northern Plateau	11	9	9	22	1	14	165	0	8	22
Western Whiptail	2	0	0	≥2	0	0	0	0	1	4-6
Tree	4	0	9	≥40	0	0	0	0	6	20-40

*See text for criteria

The few number of animals involved precluded establishing confidence limits for lizard-population data. Smith (1974) states that "A large standard error and rather wide confidence limits are the results of a small number of recaptures." To illustrate, if 9 sagebrush lizards are marked during the pre-census period and 20 lizards are seen on any day of the census period, 9 marked and 11 unmarked, the population estimate is 24 lizards. The population at the 95% level of confidence lies between 21 and 27 lizards, which is quite acceptable. Unfortunately, it required observation of at least 74% of the population if the true population was 27 lizards and more likely 83% of the population if the true population was 24 lizards. This situation has never occurred during the course of this study, and it is doubtful that mark-recapture data based on observations could ever yield population estimates with confidence intervals smaller than the population estimate itself, because an observer never sees this large a percentage of the true population in any single day. It should be noted that statistics used by biologists were developed by agronomists to deal with monocultures having little variability. Lizard populations are more difficult to deal with than a field of wheat.

3. TERRESTRIAL INVERTEBRATES

The ecological significance of each family of insect encountered on the tracts is being developed for inclusion within the Final Environmental Baseline Report.

4. AQUATIC BIOLOGY

Sample processing is incomplete, and much of the data are not available. The data will be reported when processing is complete.

a. Plankton

In response to comments received from reviewing agencies, an effort was made to modify plankton analysis. Samples were taken in the usual manner with the alpha (Wildco No. 1120) sampler. One sample was concentrated by filtering through a No. 16 XXX plankton net and processing in the usual manner, as described in Quarterly Report No. 4. The second sample was returned intact to the laboratory and

treated according to the method of Slack et al. (1973), with some modifications improvised in an effort to overcome problems with silt accumulations.

In some of the test cases, entire samples were allowed to settle; in others the entire sample was shaken and 500 ml. removed for analysis. The sedimentation period exceeded the EPA recommended 4 hour per 10 mm depth (Weber 1973). After sedimentation, all supernatant except approximately 50 ml was withdrawn and examined for plankton; in no cases were significant numbers found. The remaining concentrate was agitated to re-suspend the plankton, and an aliquot was examined in the Sedgwick-Rafter counting cell. In all of the samples examined, the sediment obscured organisms to the point that diatoms could not be detected.

This method indicates that concentrating by plankton net is the most effective method of sampling plankton in waters with extremely high concentrations of suspended solids. The net allows fine silt particles to escape and retains the coarser particles (sand) and most of the plankton. During analysis, plankton cells can be re-suspended by blowing through a pipette held against the flask bottom. The heavy sand particles settle to the bottom in approximately 5 seconds and a relatively sediment-free aliquot can be withdrawn for examination.

Sedgwick-Rafter counts of the samples concentrated by plankton-net filtration are shown on Table IV-20. The confidence levels are relatively high; however, many specialists consider concentrations of less than 500 cells per ml too dilute for accurate analysis (Weber 1973). The genera of phytoplankton were generally the same as those to be discussed in periphyton.

b. Periphyton

The extreme turbidity (transparency 2 cm) and scouring action of suspended particles had apparently retarded periphyton growth during the sampling period. Stones and other substrate that remained wetted but not submerged supported dense colonies of bright green *Cladophora glomerata*. Rapid growth of the algal filaments is suggested by the absence of the diatoms that normally form a thick epiphytic cover and cause the *Cladophora* to assume a brownish color as filaments become longer. Periphyton on the more deeply submerged stones consisted mostly of crustose blue-green algae. Standing-crop samples were collected by scraping measured areas of shale from the streambed. The samples will be analyzed by the USGS.

TABLE IV-20

PLANKTON CELL COUNTS

Station	Cells/ml
F-1	19.3
F-2	31.7
F-3	19.3
F-4	24.6
Average	23.7 cells/ml

Confidence level = 79%

Samples required for 90% confidence = 17

Fifteen periphyton sample strips were suspended at White River stations F-1, F-3, and F-5; six strips were attached to submerged conductivity probes at these stations to provide samples of more deeply submerged growth. Five samples will be removed later and sent to the USGS for analysis.

Samples exposed for the four weeks during ice-out and the onset of spring flooding were analyzed by the USGS, as seen on Table IV-21. The genera and their relative dominance was much the same as in past samplings. In the White River, Cladophora was easily the most abundant algae on shallowly submerged stones, and Phormidium appeared to dominate the deeper substrate. The streambed of Evaucation Creek was covered with a scum of diatoms consisting mostly of Navicula, Synedra (ulga?), and Amphiprora paludosa, with many other less abundant genera. A filamentous algae, Stigeoclonium sp., was locally abundant in the creek and also appeared in river samples.

The EPA developed a list of algal species from the White River during a study they are conducting in the oil-shale area (Table IV-22).

c. Macroinvertebrates

Macroinvertebrate samples were collected with the Surber sampler, Ekman dredge, and kick-screen. The samples have not been analyzed. Qualitative observations suggest that the fauna is similar to that reported in Quarterly Report No. 5, except for the abundance this year of Lachlania saskatchewanensis, a mayfly whose nymphs inhabit clumps of debris and vegetation that become lodged in the streambed. Only a few nymphs were collected in September 1975, but they were abundant during mid-August 1976, as late instar nymphs and as adults. Traverella albertana, also a mayfly, was again the most abundant immature insect. Unlike L. saskatchewanensis, T. albertana shuns vegetative debris. Its favorite habitat is fist-sized or larger stones in very shallow water. The nymphs exhibit a strong tendency to clump. Most streambed stones will harbor only one or two nymphs, but occasionally a stone will be almost solidly covered with nymphs.

Fauna of the silted and sandy bottom areas appeared to be depauperate (stunted/dwarfed). Twelve Ekman samples taken along the left bank of the pool at Station F-1 contained only about 20 chironomid larvae and a few dragonfly nymphs. Samples have not been analyzed, but those from other stations appeared to have similarly low densities.

TABLE IV-21

PERIPHYTON DATA

Station F-1 (Evacuation Creek)

Biomass (Peri) Ash G/M^2	252		Biomass Pigment Ratio	420
Biomass (Peri) Dry G/M^2	268		Chlrphyl (Per) A MG/M2	37.1
Biomass G/M^2	15.6			

Station F-3 (White River near Bonanza Bridge)

Biomass (Peri) Ash G/M^2	22.9	Biomass Pigmnt Ratio	570
Biomass (Peri) Dry G/M^2	27.2	Chlrphyl (Per) A MG/M2	7.55
Biomas G/M^2	4.3	Chlrphyl (Per) B MG/M2	9.0

Station F-4 (White River near Southam Canyon)

Biomass (Peri) Ash G/M^2	2.31	Biomass Pigmnt Ratio	550
Biomass (Peri) Dry G/M^2	2.85	Chlrphyl (Per) A MG/M2	0.979
Biomass G/M^2	0.538	Chlrphyl (Per) B MG/M2	0.0

Station F-6 (Evacuation Creek)

Biomass (Peri) Ash G/M^2	1.54	Biomass Pigmnt Ratio	
Biomass (Peri) Dry G/M^2	1.92	Chlrphyl (Per) A MG/M2	0.0
Biomass G/M^2	0.38	Chlrphyl (Per) B MG/M2	0.0

TABLE IV-22

ALGAL TAXA REPORTED BY EPA*

Chlorophyta

Actinastrum sp.

Cladophora glomerata

Closterium sp.

Cosmarium sp.

Filament movgeolia sp.

Stigeoclonium sp.

CYANOPHYTA

Anabaena sp.

Calothrix sp.

Lyngbya sp.

Oscillatoria agardhi

Phormidium sp.

EUGLENOPHYTA

Euglena spp (4)

Lepocinclis fusiformis

CHRYSOPHYTA BACILLARIOPHYCEAE (DIATOMS)

Amphora sp.

Ampiphora

Cyclotella

Cymatopleura solea

Diatoma sp.

Gomphonema olivaceum

Gyrosigma sp.

Navicula lanceolata

Navicula sp.

Nitzschia tryblionella

Nitzschia spp. (2)

Pinnularia

Rhopalodia gibba

Surirella sp.

Surirella ovata

Synedra ulna

*Evan Hornig, personal communication

During the course of the baseline study, certain groups of organisms have been conspicuous by their absence. One such group is the leeches: None have been collected until the current sampling, when approximately 25 were removed from channel catfish, flannel-mouth suckers, and roundtail chubs. The organisms have been sent to an oligochaete specialist with VTN for identification. Their identity and characteristics will be reported later.

d. Fishery

Investigations of fisheries consisted of angling (hook and line) and seining in accordance with the 1976 Utah Department of Wildlife Resources Aquatic Wildlife Proclamation. Two channel catfish (*Ictalurus punctatus*) measuring 43.2 cm and 35.5 cm (17 in. and 14 in.) and weighing 474 g and 171 g (1.2 lb and 0.4 lb), respectively, were taken by hook and line. The larger specimen was infested with approximately 20 leeches.

Seining was conducted at Station F-2 and in the small meander below Ignacio Bridge at Station F-3. Fish were captured at Station F-2 along the base of the riffle shown within the outline in Figure IV-5, *Quarterly Report No. 7*, by using a 1-m^2 section of window screen. The screen was operated from upstream toward downstream in water approximately 30 cm deep.

At Station F-3 fish were sampled in the meander illustrated in *Quarterly Report No. 3* (Figure IV-9). The meander is approximately 65 m (210 ft) long and 2.5 m (8 ft) wide. A bar mesh seine 6.2 m x 1.2 m (20 ft x 4 ft) with 1/4-in. (0.6-cm) mesh was used at Station F-3. Sampling was conducted on consecutive days at both stations using identical procedures on both days. The results are shown on Table IV-23.

The above data are probably unsuitable for population estimates because of the low recapture ratio at Station F-2 and possibly the mortality at Station F-3. The Station F-2 sampling was conducted in the open river, where considerable fish movement occurs. The meander at Station F-3 is narrow and shallow at both ends, a factor that would seem to confine the population, and yet the data suggest that considerable in-and-out movement occurs. Application of the Peterson (Lincoln) index to Station F-3 data would indicate a total population of approximately 430; however, the meander was seined twice on the recapture attempt, and successive hauls produced 75 and 31 fish, respectively (there were 17 recaptures in the first haul and 2 on the

TABLE IV-23

FISHERY CAPTURE - RECAPTURE DATA

Station	Day 1	Day 2
F-1	Captures 78 Mortality 16	Captures 105 Recaptures 19
F-2	Captures 60 Mortality 3	Captures 75 Recaptures 2

TABLE IV-24

WHITE RIVER FISH SPECIES

Common Name	Generic Name	F-2	F-3
Speckled dace	*Rhinichthys osculus*	74	53
Flannelmouth sucker	*Catostomus latipinnis*	0	19
Bluehead sucker	*Catostomus delphinus*	1	0
Channel catfish	*Sctalurus punctatus*	0	25
Black bullhead	*Ictalurus melas*	0	1
Roundtail chub	*Gila robusta*	0	3
Red shiner	*Notropis lutrensis*	0	3
Carp	*Cyprinus carpio*	0	1
	Total	75	105

second haul). Plotting the data on a regression curve indicated a population of approximately 130. The species and numbers of fish taken on the recapture day are shown on Table IV-24.

5. MICROBIOLOGY

a. Microbial Numbers

As expected from past experiences, microbial plate counts exhibited low correlations with metabolic indicators such as respiration and dehydrogenase activity; however, the plate counts do correlate with moisture trends expressed as the percent water. Like moisture availability, aeration (O_2 availability) is also a limiting factor, and thus, although water is being retained at lower depths, less microbial activity is evident at the 40-cm to 50-cm depth at all sites in the case of aerobic bacteria and fungi.

As expected, anaerobic bacteria increased in the lower profiles where moisture is sufficient and aeration is not critical. Microbial numbers for the current reporting period were generally higher than for the same period last year. Microbial activity is recorded on Table IV-25 through Table IV-28.

b. Dehydrogenase Activity

Dehydrogenase levels indicate continued use of available organic substrate through June and reflect a state of considerably higher biological activity than noted during the same period in 1975. Litter samples, and particularly litter from the shadscale area (site 58), exhibited the greatest overall activity. The values were the lowest at site 39, as expected because of low organic carbon availability. Large increases in dehydrogenase activity were evident in the juniper litter and surface soil of site 58, whereas all other sites showed slight decreases in activity from late May through June. Dehydrogenase data from the May and June samples are listed on Table IV-29.

c. Respiration

Respiration (biological release of CO_2) increased slightly from May to June in the surface layer of site 39 with a

TABLE IV-25

AEROBIC BACTERIA
NUMBER PER GRAM OF SOIL

SAMPLE	28 MAY 1976	30 JUNE 1976	13 AUGUST 1976
39-1	1.05×10^6	1.86×10^6	1.96×10^5
39-2	1.16×10^6	2.32×10^6	2.14×10^5
39-3	8.90×10^5	1.68×10^6	1.30×10^4
50JC-1	1.32×10^6	1.04×10^6	1.50×10^6
50JI-1	1.06×10^6	1.46×10^6	9.40×10^5
55R-1	4.67×10^6	8.36×10^6	1.38×10^6
55R-2	4.10×10^6	2.70×10^6	6.30×10^5
55R-3	4.30×10^6	6.78×10^6	7.80×10^5
58C-1	1.01×10^6	7.86×10^6	6.30×10^5
58C-2	8.40×10^6	1.49×10^7	1.23×10^6
58C-3	5.90×10^6	7.04×10^6	8.30×10^5
58I-1	4.50×10^6	2.40×10^6	6.20×10^5
58I-2	4.00×10^6	1.90×10^6	8.92×10^5
58I-3	1.28×10^6	1.94×10^6	7.80×10^5
50J-L	5.90×10^5	6.40×10^6	2.34×10^7
58-L	1.47×10^6	--	--

TABLE IV-26

ANAEROBIC BACTERIA
NUMBER PER GRAM OF SOIL

SAMPLE	28 MAY 1976	30 JUNE 1976	13 AUGUST 1976
39-1	1.70×10^3	3.30×10^4	7.30×10^3
39-2	7.40×10^4	5.30×10^4	5.30×10^3
39-3	5.60×10^3	4.00×10^3	3.30×10^3
50JC-1	7.60×10^3	1.50×10^4	3.70×10^4
50JC-1	1.30×10^4	2.40×10^4	1.00×10^4
55R-1	2.10×10^4	1.40×10^4	0.10×10^4
55R-2	2.13×10^4	9.00×10^3	6.70×10^3
55R-3	2.46×10^4	5.30×10^3	9.00×10^3
58C-1	2.50×10^4	1.16×10^5	1.20×10^4
58C-2	1.90×10^4	5.30×10^4	2.30×10^4
58C-3	1.60×10^4	2.23×10^4	1.00×10^4
58I-1	3.00×10^3	2.67×10^3	2.60×10^3
58I-2	5.00×10^3	3.70×10^3	3.00×10^3
58I-3	2.60×10^3	3.30×10^4	5.60×10^3
50J-L	3.30×10^3	2.00×10^3	3.00×10^3
58-L		--	--

TABLE IV-27

STREPTOMYCETES

NUMBER PER GRAM OF SOIL

SAMPLE	28 MAY 1976	30 JUNE 1976	13 AUGUST 1976
39-1	8.10×10^5	4.40×10^5	2.50×10^5
39-2	4.60×10^5	2.68×10^6	5.20×10^4
39-3	2.70×10^5	1.10×10^6	3.20×10^4
50JC-1	6.70×10^5	4.40×10^5	5.16×10^5
50JI-1	7.20×10^5	1.16×10^6	4.74×10^5
55R-1	8.67×10^5	3.20×10^6	2.76×10^5
55R-2	4.60×10^5	1.38×10^6	1.40×10^5
55R-3	1.00×10^6	6.60×10^5	1.96×10^5
58C-1	6.90×10^5	2.40×10^6	1.98×10^5
58C-2	1.50×10^6	3.40×10^6	4.50×10^5
58C-3	1.00×10^6	2.96×10^6	3.16×10^5
58I-1	1.26×10^6	4.68×10^6	3.10×10^5
58I-2	1.60×10^6	8.80×10^5	2.70×10^5
58I-3	7.10×10^5	1.40×10^6	2.56×10^5
50J-L	2.50×10^5	1.60×10^5	4.00×10^4
58-L	2.60×10^5	--	--

TABLE IV-28

FUNGI

NUMBER PER GRAM OF SOIL

SAMPLE	28 MAY 1976	30 JUNE 1976	13 AUGUST 1976
39-1	1.80×10^4	3.80×10^3	4.60×10^3
39-2	2.10×10^4	9.20×10^3	4.80×10^3
39-3	1.50×10^4	1.30×10^4	1.40×10^3
50JC-1	4.90×10^4	3.04×10^4	4.70×10^4
50JI-1	8.30×10^3	1.28×10^4	1.00×10^4
55R-1	7.00×10^4	5.26×10^4	3.10×10^4
55R-2	3.26×10^4	9.80×10^3	1.30×10^4
55R-3	3.26×10^4	7.60×10^3	5.60×10^3
58C-1	3.16×10^4	4.42×10^4	3.00×10^4
58C-2	3.96×10^4	5.64×10^4	2.20×10^4
58C-3	2.90×10^4	4.20×10^4	1.60×10^4
58I-1	9.00×10^3	1.18×10^4	3.80×10^3
58I-2	6.30×10^3	8.80×10^3	1.56×10^4
58I-3	4.00×10^3	9.60×10^3	1.00×10^4
50J-L	4.90×10^4	4.20×10^4	4.30×10^4
58-L	6.40×10^4	--	--

TABLE IV-29

DEHYDROGENASE ACTIVITY

FORMAZAN mg/ml

SAMPLE	28 MAY 1976	30 JUNE 1976
39-1	0.050	0.034
39-2	0.036	0.019
39-3	0.019	0.013
50JC-1	0.333	0.313
50JI-1	0.222	0.218
55R-1	0.362	0.152
55R-2	0.108	0.018
55R-3	0.067	0.014
58C-1	0.252	0.315
58C-2	0.185	0.093
58C-3	0.139	0.068
58I-1	0.188	0.126
58I-2	0.016	0.011
58I-3	0.025	0.013
50J-L	0.796	0.827
58-L	2.260	--

significant decrease noted in mid-August. Conversely, at the 5-cm to 20-cm and 40-cm to 50-cm depth, CO_2 levels declined from May to June and increased in August. The site 58C surface sample followed the same pattern except for a general increase in respiration levels from May through mid-August.

Depth samples at the riparian site (55C) exhibited the highest CO_2 levels in May, but the levels decreased sharply in June and increased slightly again in August. Activity at the site 55R surface sample decreased steadily from May through mid-August. In late June respiration fell from a high of 16.78 and 24.29 (May) to zero and 3.87 µmoles CO_2/g/min in canopy and interspace soils at the juniper site (50J). In both samples the values rose again slightly in mid-August. At site 58I-1 and site 58I-2 values dropped steadily throughout the sampling period, whereas at site 58I-3 values increased steadily over the same period.

The generally lower CO_2 levels noted in the surface samples reflect moisture retention in the lower profiles at all sites. Overall, respiration values during the current period were higher than over the same period in 1975. Respiration data are listed on Table IV-30.

d. Water Potential

Water-potential data reflect the moisture retention in the lower depths throughout the sampling period. As noted above, moisture retention is responsible in part for the higher activities (respiration and dehydrogenase) observed in the lower profile. Sites 39, 50JC, and 50JI, experienced a characteristic drying period from late May through mid-August--from 15.5 to 194.0 -bars in sample 39-1. The rest of the sites were subject to a slight moisture influx, as indicated by a reduction in water potential in June and an increase in water tension at all sites in August.

Water-potential data generally correlates well with biological activities; however, as with 1975 data, statistical methods will be implemented to compare environmental and biological parameters to define their relationships more accurately. Water-potential data for the current period are listed on Table IV-31.

TABLE IV-30

RESPIRATION

μ moles CO_2/g/min

SAMPLE	28 MAY 1976	30 JUNE 1976	13 AUGUST 1976
39-1	12.32	13.10	4.47
39-2	18.14	5.66	20.99
39-3	22.22	4.15	18.79
50JC-1	16.78	0	4.97
50JI-1	24.29	3.87	8.19
55R-1	25.38	22.80	12.14
55R-2	35.04	12.01	16.09
55R-3	33.35	11.91	13.90
58C-1	6.20	17.65	6.68
58C-2	8.97	9.50	11.39
58C-3	0.41	7.20	9.50
58I-1	10.40	7.98	6.71
58I-2	11.74	4.49	4.19
58I-3	3.93	5.66	10.69
50J-L	31.20	12.12	15.67
58-L	18.84	--	--

TABLE IV-31

WATER POTENTIAL

-BARS

SAMPLE	28 MAY 1976	30 JUNE 1976	13 AUGUST 1976
39-1	16	67	194
39-2	22	93	86
39-3	14	60	74
50JC-1	19	163	180
50JI-1	31	152	190
55R-1	21	17	139
55R-2	8.0	3.0	61
55R-3	8.0	9.0	92
58C-1	25	2.6	140
58C-2	13	7.8	47
58C-3	13	19	50
58I-1	38	10	178
58I-2	7.4	6.4	69
58I-3	15	12	72
50J-L	11	252	214
58-L	13	--	--

e. Moisture Content

Percent moisture content generally followed the inverse trend of water potential. Overall, the moisture content was highest at the riparian site (55R), as expected, and lowest at site 39. Moisture data reflected the general drying trend observed with the approach of summer. The data are listed on Table IV-32.

f. Organic Carbon Content

Figure IV-5 depicts the variation in the percent of organic carbon at each site over the 1975 sampling season. The graph shows that organic carbon content was highest in soil under the canopy at the juniper site (50J) and lowest in the interspace soil at site 58. Two seasonal peaks were evident at all reported sites over the collection period--one in late spring and one in late summer. The first was probably due to the incorporation into the soil of weathered organic matter after snowmelt and the second in part to organic carbon released from new-fallen litter.

Because the percentage of organic carbon in the soil is an indicator of the relative amount of substrate available for microbial metabolism, the extent of its relationship with respiration measurements was statistically analyzed for the wet and dry conditions of the 1975 season. Wet conditions were defined as soils exhibiting a water potential of less than 50 -bars, and dry conditions as greater than 50 -bars. It was subsequently deduced that although on the average a difference of only 0.06% organic carbon existed between wet and dry conditions, respiration was an average of 19.01% higher during wet periods than during dry (see Figure IV-6).

Except at site 39, organic carbon values were lower than those of the same time in 1975, and except for the juniper interspace site (50J), all values were higher than those of April 1976. From May to June the percentage of organic carbon decreased at all sites except in the interspace soil at site 58. The percentages of organic carbon during the current reporting period are listed on Table IV-33.

g. Total Nitrogen Content

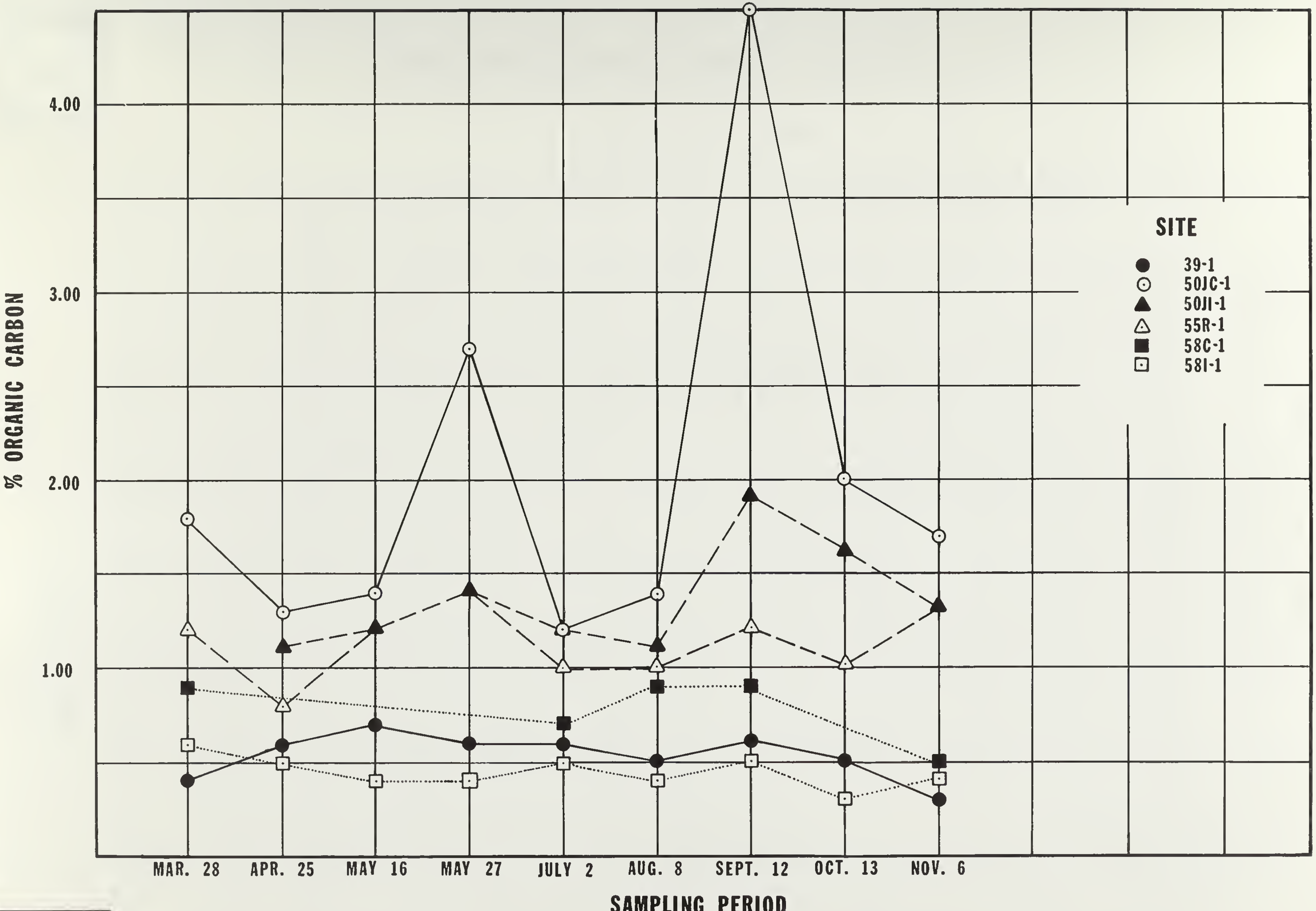
Trends in the total nitrogen content in surface soils over the 1975 sampling period are shown on Figure IV-7. As with

TABLE IV-32

MOISTURE CONTENT

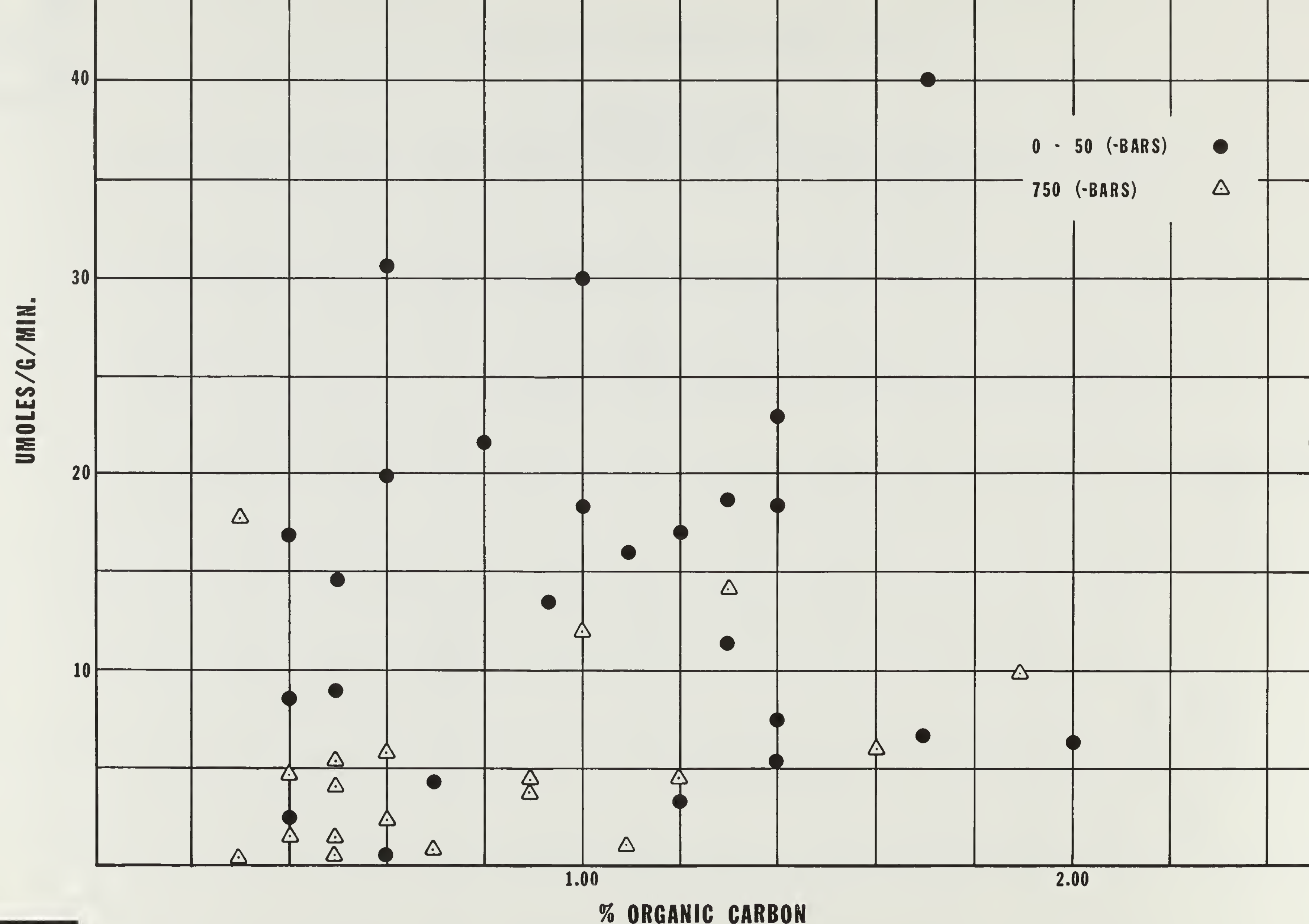
% MOISTURE

SAMPLE	28 MAY 1976	30 JUNE 1976	13 AUGUST 1976
39-1	1.81	4.40	1.50
39-2	7.01	6.79	8.43
39-3	8.66	5.08	9.45
50JC-1	8.93	3.21	2.70
50JI-1	4.23	3.26	3.43
55R-1	22.63	11.48	2.20
55R-2	17.18	13.83	3.01
55R-3	20.39	15.13	3.63
58C-1	4.17	9.59	1.16
58C-2	4.94	7.97	3.53
58C-3	5.07	5.86	4.02
58I-1	3.62	7.14	1.60
58I-2	6.76	8.13	3.01
58I-3	6.35	6.77	3.36
50J-L	7.57	6.27	7.86
58-L	4.66	--	--



PERCENTAGE OF ORGANIC CARBON - 1975

FIGURE IV-5



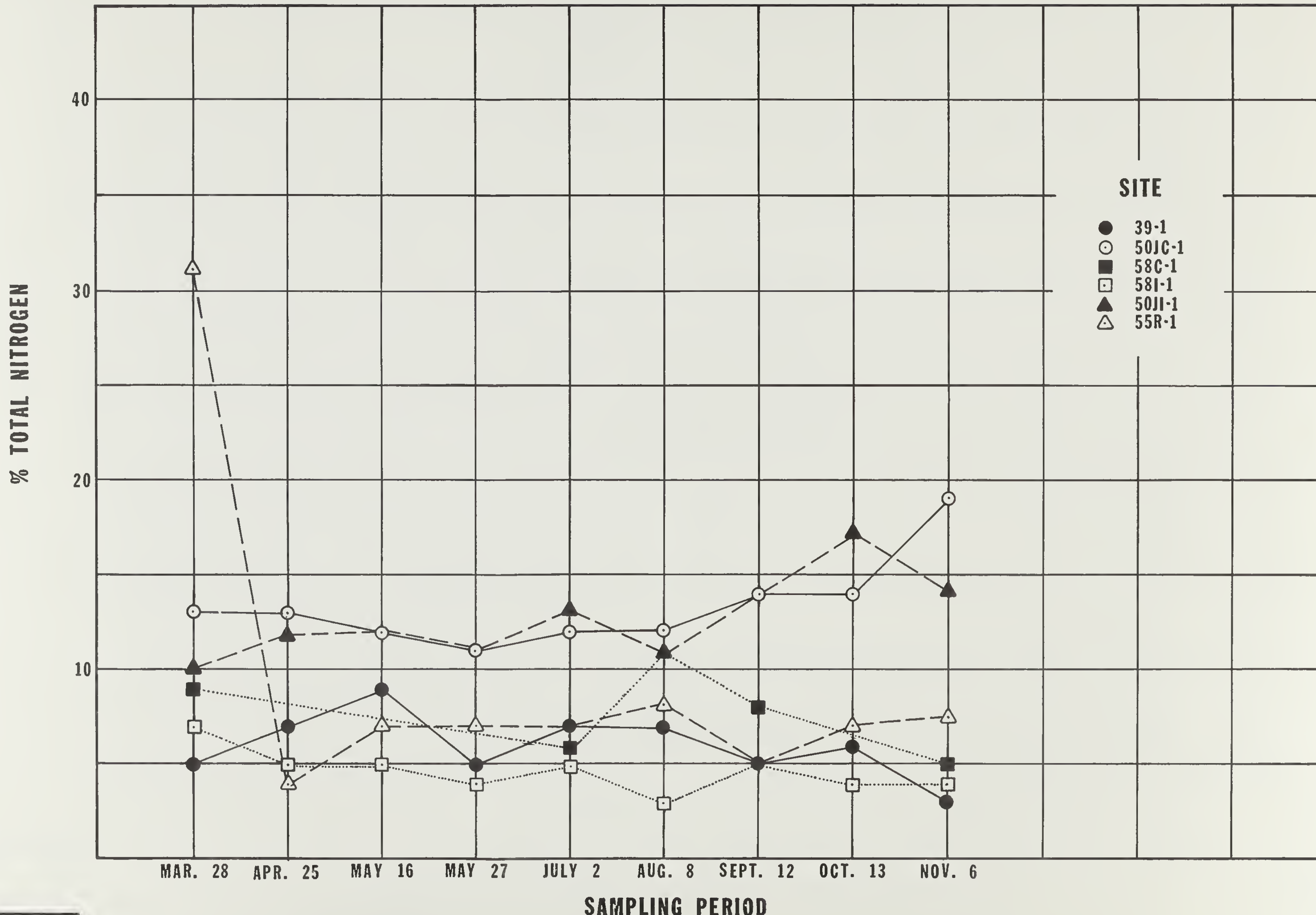
PERCENTAGE OF ORGANIC CARBON VS. RESPIRATION - 1975

FIGURE IV-6

TABLE IV-33

ORGANIC CARBON AND TOTAL NITROGEN CONTENT

SAMPLE	28 MAY 1976			30 JUNE 1976		
	% Org. C.	% Total N	C/N	% Org. C.	% Total N	C/N
39-1	0.57	0.06	9.5	0.38	0.04	9.5
39-2	0.47	0.06	7.8	0.49	0.05	9.8
39-3	0.40	0.05	8.0	0.40	0.05	8.0
50JC-1	2.03	0.17	11.9	1.67	0.13	12.8
50JI-1	1.11	0.11	10.1	1.00	0.13	7.7
55R-1	1.32	0.12	11.0	0.98	0.06	16.3
55R-2	0.67	0.05	13.4	0.76	0.05	15.2
55R-3	0.79	0.05	15.8	0.53	0.04	13.3
58C-1	1.18	0.11	10.7	0.70	0.08	8.8
58C-2	0.69	0.07	9.9	0.57	0.06	9.5
58C-3	0.46	0.05	9.2	0.43	0.04	10.8
58I-1	0.34	0.05	6.8	0.60	0.06	10.0
58I-2	0.26	0.04	6.5	0.49	0.05	9.8
58I-3	0.31	0.03	10.3	0.33	0.04	8.3
50J-L	--	--	--	6.30	0.25	25.2
58-L	--	--	--			



PERCENTAGE OF TOTAL NITROGEN - 1975

FIGURE IV-7

the percentage of organic carbon, the total nitrogen content was highest in soil under the canopy at the juniper site and lowest in the interspace soil at site 58. On March 28 the riparian surface soil contained 0.25% total nitrogen as compared with the average of 0.06% for all riparian samples for the rest of the year. Overall, all sites (except 55R) remained relatively consistent over the seasons with no clear patterns in the total percentage of total nitrogen.

All sites analyzed for May 28, 1976, showed slightly higher percentages of total nitrogen than did samples taken on equivalent dates in 1975. Sites 50JC-1 and 55R-1 exhibited the highest total nitrogen content--0.17 and 0.12%, respectively--whereas the 40 cm to 50 cm depth at site 58I was lowest--0.03% for May 28, 1976. The total nitrogen content decreased overall from May to June. The data for the current reporting period are listed on Table IV-33.

h. Carbon/Nitrogen Ratio (C/N)

Carbon/nitrogen ratios were lower overall than at the same time last year, reflecting the higher total nitrogen values and generally lower percentages of organic carbon this year. Other than the riparian and site 58 interspace soils, all surface samples had higher C/N ratios than did April samples, indicating a gradual slowdown in the decomposition process with the approach of summer. Carbon/nitrogen ratios for May 1976 samples are listed on Table IV-33.

i. Nitrate Content

Except for the riparian site (55), in all samples the levels of nitrate (NO_3-N) nitrogen were higher than at the same time in 1975. The surface sample at site 58 contained the highest level, 2.03 µg/g, and sample 50JC-1 the lowest, 0 µg/g. Nitrate levels were the highest in surface samples and decreased through the lower horizons. The data indicate the probable leaching of NO_3 in April subsided, and nitrate increases were noted at all sites from May to June. Nitrate-content data are listed on Table IV-34.

j. pH

The pH values for the current reporting period are listed on Table IV-35. The pH values were generally consistent with those of the same period last year. Overall, pH appears

TABLE IV-34

NITRATE CONTENT

μg/g NO_3^--N

SAMPLE	28 MAY 1976	30 JUNE 1976
39-1	0.25	1.40
39-2	0.13	0.70
39-3	0.13	0.80
50JC-1	0	0.30
50JI-1	0.18	0.80
55R-1	1.25	1.60
55R-2	0.18	0.60
55R-3	0.15	0.30
58C-1	2.03	8.90
58C-2	0.80	3.20
58C-3	0.50	2.30
58I-1	0.40	1.50
58I-2	0.33	1.30
58I-3	0.23	0.90
50J-L	--	0.40
58-L	--	--

TABLE IV-35

pH VALUES

SAMPLE	28 MAY 1976	30 JUNE 1976	13 AUGUST 1976
39-1	7.9	8.8	8.3
39-2	8.2	8.2	8.9
39-3	8.3	8.2	8.8
50JC-1	7.6	7.7	6.9
50JI-1	7.7	7.8	7.8
55R-1	8.2	8.6	7.9
55R-2	8.3	8.4	8.1
55R03	8.3	8.4	8.2
58C-1	9.0	8.1	9.1
58C-2	9.6	9.0	9.4
58C-3	9.7	9.0	9.5
58I-1	7.7	8.2	8.2
58I-2	8.1	8.3	8.9
58I-3	8.1	8.4	9.2
50J-L	8.0	6.9	7.2
58-L	9.3	--	--

consistently highest in samples under the canopy of site 58 and lowest under the juniper canopy, due in part to the acids released during degradation of organic matter.

k. Total Ammonium Nitrogen (NH_4-N)

Total NH_4 -N values are listed on Table IV-36. The values were high over the current period, with litter samples as well as canopy soils having the highest levels. Ammonium nitrogen generally increased from May to June and more than doubled in the juniper site soils. The high values indicate continued mineralization of organic nitrogen accompanying the decomposition process of litter, especially at the canopy sites.

l. Proteolytic Activity

The proteolytic activity in spring samples fluctuated, dropping considerably from mid-March to late April and increasing to its highest levels in late May. An overall decrease in proteolysis was apparent at the end of June. The values were highest in the litter, as expected considering their greater substrate availability. High activity was also measured at the riparian site. Overall values were slightly higher than at the same time in 1975. Proteolytic activity from March through June are seen on Table IV-37.

C. WORK SCHEDULED

1. VEGETATION

During the final quarter of the baseline study (September 15 to December 15) the last phenological assessment will take place in mid October and the current year's growth of sagebrush will be measured in mid October.

Phenology and sagebrush data will be summarized prior to the review of all data collected for the past two years. Appropriate comparisons and interpretations will be made in the Final Environmental Baseline Report, to be drafted during December.

TABLE IV-36

TOTAL AMMONIUM (NH_4^+) NITROGEN
µg N/g SOIL

SAMPLE	28 MAY 1976	30 JUNE 1976
39-1	41.33	42.99
39-2	38.95	82.33
39-3	31.19	59.02
50JC-1	118.95	254.85
50JI-1	71.87	222.57
55R-1	77.26	95.15
55R-2	31.17	69.58
55R-3	30.34	46.05
58C-1	84.22	107.32
58C-2	50.32	76.07
58C-3	30.89	66.98
58I-1	23.57	90.68
58I-2	15.69	31.36
58I-3	15.63	40.89
50J-L	704.04	670.33
58-L	325.29	---

TABLE IV-37

PROTEOLYTIC ACTIVITY

% HYDROLYSIS

SAMPLE	18 MARCH 1976	26 APRIL 1976	28 MAY 1976	30 JUNE 1976
39-1	9.22	1.11	16.04	11.33
39-2	5.80	1.96	5.89	3.84
39-3	4.33	3.57	2.66	2.63
50JC-1	33.30	24.32	24.35	6.76
50JI-1	27.16	20.86	14.12	4.65
55R-1	36.70	27.88	33.66	24.47
55R-2	10.15	13.28	15.12	19.23
55R-3	11.54	10.77	20.65	16.10
58C-1	22.56	14.06	34.27	12.66
58C-2	18.82	9.71	28.49	11.72
58C-3	16.93	8.14	24.32	4.82
58I-1	8.58	3.89	15.59	5.30
58I-2	7.62	2.78	13.67	4.27
58I-3	5.67	2.13	11.80	4.43
50J-L	86.86	--	39.59	9.35
58-L	53.00	00	27.84	--

2. TERRESTRIAL VERTEBRATES

Bird, Mammal, reptile, and amphibian transects will be walked and rodents live trapped during October. Large mammal monitoring will continue through project completion. The final reporting of the results of the amphibian and reptile program, including comparison of the two years' data, is scheduled for October 1976.

3. TERRESTRIAL INVERTEBRATES

Accumulated information will be organized in preparation for drafting the Final Environmental Baseline Report.

4. AQUATIC BIOLOGY

The August sampling completes the two-year baseline data collection effort. Periphyton sampling will continue until October, and further fishery work may be conducted by the Utah Division of Wildlife Resources. The samples now available will be sorted and analyzed, the data reduced, and the results detailed in The Final Environmental Baseline Report.

5. MICROBIOLOGY

Laboratory analysis will be completed and the first draft of the Final Environmental Baseline Report prepared.

REFERENCES

Slack, K.V., R.C. Averett, P.E. Greeson and R.G. Lipscomb. 1973. Methods for Collection and Analysis of Aquatic Biological and Microbiological Samples. U.S. Geological Survey.

Smith, R.L. 1974. Ecology and Field Biology. New York: Harper and Row.

Stebbins, R.C. 1966. A Field Guide to Western Reptiles and Amphibians. Boston, Massachusetts: Houghton Mifflin Co.

V. SOILS

A. WORK COMPLETED

The surface horizons of each of the soil series at the site were sampled to determine heavy-metal content for antimony, cadmium, fluorine, mercury, and selenium as specified in the Revised Conditions of Approval, dated February 23, 1976. One sample was taken from the surface horizon of A, A_s, B, B_s, E, N, F, and W soils. Only the surface horizon (A1) of each soil type was sampled because it is lowest in pH, and subsequently the elements there are the most mobile and available. Also, organic matter is an important secondary source of some of the trace elements, and therefore in uncultivated profiles there is a somewhat greater concentration of trace elements near the surface.

The methods used to extract the elements from the soil do not give the total concentration but rather an approximation of the elements available to plants. Antimony and cadmium were extracted by the APDC method; fluoride and selenium, by hot water; and mercury, with a mild sulfuric permanganate digestion. Antimony and cadmium were read by atomic absorbtion; fluorine, using the SPADNS method; selenium by DAN fluorimetry; and mercury, by flameless atomic absorbtion. The limits of sensitivity for the tests are 0.01 ppm for cadmium, mercury, and selenium; 0.02 ppm for fluorine; and 0.1 ppm for antimony.

B. DATA SUMMARY

1. ANTIMONY (Sb)

Plant-available antimony was below the reporting minimum (0.1 ppm) in every soil, and therefore levels on the tracts are probably not deleterious. Antimony is probably very similar in chemical behavior to arsenic in that antimony is relatively unavailable for plant growth and uptake (the normal range of arsenic in soils is 0.1 ppm to 40 ppm).

2. CADMIUM (Cd)

Cadmium is known to accumulate in animals, but there is little information concerning cadmium reactions in soil. The chemical similarity to zinc suggests that it should

behave in soil much as zinc does, i.e., at a pH of 6.5 and above it is of low availability to plants, especially if it is present in high valence forms. The soil probably ties up (retains) relatively large quantities of cadmium if the soil pH is high and the drainage good (Brady 1974). The concentration of cadmium in soils usually ranges from 0.1 ppm to 7 ppm. Cadmium concentrations in the soils of the site were less than 0.01 ppm in all samples and are therefore probably not deleterious.

3. FLUORIDE (F)

There is no report of fluoride toxicity from fluorides taken up by the roots of plants, translocated in the tops, and eaten by animals (Allaway 1968). The fluorides formed in soils are highly insoluble, especially in soil well supplied with lime (Brady 1974). Fluoride is commonly found in soils in concentrations of between 30 ppm and 300 ppm. The Fluoride levels were well below 1.1 ppm in all samples, a level not considered deleterious.

4. MERCURY (Mg)

Inorganic mercury compounds added to soil reacts quickly with organic matter and clay minerals to form insoluble compounds. In this form the mercury is unavailable to growing plants, although it can be converted to more available forms. Mercury levels at the site are probably not deleterious, since all were below the reporting minimums (0.01 ppm).

5. SELENIUM (Se)

Unlike the other elements tested, selenium in alkaline, well-aerated soil will oxidize to selenates that are not strongly absorbed or fixed and are generally available to plants (Allaway 1968). The level normally found in soil is 0.1 ppm to 2.0 ppm. Soils containing 1 ppm of selenium may produce accumulated levels of up to 4 ppm in plants, which is toxic to most animals (Donahue 1971).

Dean Lansing, of Colorado Analytical Labs (pers. comm. 1976), noted that 0.1 ppm of available selenium in soils may be deleterious to plants or to the animals that feed on them. This would be unlikely in the soils of the site, since in

all samples selenium levels were less than the reporting minimum (0.01 ppm).

Refer to Table V-1 for trace element results.

C. WORK SCHEDULED

No further work is scheduled for the soils program

REFERENCES

Allaway, W.H. 1968. "Agronomic Controls over the Environmental Cycling of Trace Elements." Advances in Agronomy 20: 235-274.

Brady, Nyle C. 1974. The Nature and Properties of Soils. 8th ed. New York: Macmillian Publishing Co.

Donahue, Roy L.; Shickluna, John C.; and Robertson, Lynn S. 1971. Soils: An Introduction to Soils and Plant Growth. 3rd ed. Englewood Cliffs, N.J.: Prentice-Hall Inc.

TABLE V-1

SOILS TRACE ELEMENT RESULTS

Soil	Sb	Cd	F	Hg	Se
A	-.1	-.01	.4	-.01	-.01
W	-.1	-.01	1.1	-.01	-.01
As	-.1	-.01	.7	-.01	-.01
Bs	-.1	-.01	.7	-.01	-.01
E	-.1	-.01	1.0	-.01	-.01
F	-.1	-.01	.8	-.01	-.01
N	-.1	-.01	.8	-.01	-.01
B	-.1	-.01	.8	-.01	-.01
Ds	-.1	-.01	1.0	-.01	-.01

Minus sign indicates less than reporting minimums. All values are in parts per million.

VI. REVEGETATION STUDIES FOR DISTURBED AREAS AND PROCESSED SHALE DISPOSAL AREAS

A. WORK COMPLETED AND RESEARCH PROGRESS

The Agricultural Experiment Station at Utah State University(USU) has made considerable progress in several areas of the research program. The program has resulted in additional information about how to propagate some native species by seeds or cuttings, how to cope with the variable weather on the tracts, the minimum fertilizer requirements of native plants, and the pattern of salinity movement or accumulation in surface areas at processed shale disposal piles. Additional progress in the program includes the following:

1. Mr. Kent Krofts has compiled a bibliography on the propagation and establishment of perennial *Atriplex* as part of another project for the Institute for Land Rehabilitation. The bibliography will be useful in developing methods for using the three saltbush species native to the oil-shale area for revegetating processed oil-shale disposal areas.

2. Seeds of species in which there is a special interest for revegetation have been collected and developed for cleaning and storage.

3. Four saltbush species native to the oil-shale area again have been investigated for optimum seed collecting time and handling, optimum seed size, optimum utriche-wall thickness, and optimum seed weights. Few conclusions can be formulated at this time, but selection for certain seed characteristics in *Atriplex* could possibly influence seedling vigor. The detailed results of this project will be reported upon completion.

4. Containerized plants for revegetation has proved successful in many areas. Four types of containers and three different shrubs were used in the study to evaluate the performance of container-grown plants during greenhouse propagation and after out planting. There was little variation produced among species, but great variation between container types. It is evident that container type influences plant growth; whether or not this is harmful to plant performance in the field will be determined later in the study.

5. Studies of physiological reactions of several native shrub species indicate that some species grow well on fertilized, raw, processed oil shale with pH values of up to 9 and that higher values inhibit plant growth. Shadscale and fourwing saltbush were found to tolerate high salinity levels (osmotic potentials of up to -25 atm) of NaCl and Na_2SO_4; in fact, shadscale growth was enhanced by moderate salinity (-10 atm). The study also indicates that several species respond in different ways to different forms of nitrogen fertilizer (nitrate versus ammonium) in processed oil shale and that the responses are modified by the pH and salinity levels of the processed oil shale.

6. Three shrub species were tested for their ability to root from cuttings from mature plants. The variability between plants and rooting ability is unknown. Both winterfat and saltbush demonstrated a consistent ability to root from cuttings.

7. Rehabilitation plantings on disturbed sites are being studied to determine the success of direct seeding, greenhouse propagated material, and the season of planting. Superior results may be obtained by planting container-grown plants. Direct seeding was more successful in grass species than in other plant species. Species demonstrating good success from fall seedings also did well in spring seedings.

8. Six soil surface stabilizing materials were applied at various rates over a 12-month period. Only the high rate of the polyvinyl acetate soil seal out the Aerospray 70 were intact to any degree. Plantings at the lower end of each plot were in excellent condition, indicating that surface runoff and the absence of plant competition were favorable for growth.

B. DATA SUMMARY

USU's third progress report entitled Revegetation Studies for Disturbed Areas and Processed Shale Disposal Site is included within the Field Data Section of Quarterly Report No. 8.

C. WORK SCHEDULED

Work in the next six months will include development of a small pilot model of a processed shale pile to determine water runoff, percolation, and salinity movement and accumulation of salts in the top 1 m to 1.2 m (3 ft to 4 ft) of a disposal pile. In other field studies, soil surface stabilizing materials, root growth of container-grown plants, and survival of plants outplanted in fall and spring will be studied. Laboratory studies will concentrate on plant growth on processed oil shale in relation to various salts and means to ameliorate the adverse effects of salinity and low fertility.